
APPENDIX A

NASA EARTH SCIENCE RESEARCH STRATEGY FOR 2000-2010

Executive Summary

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural or human-induced changes to enable improved prediction capability for climate, weather, and natural hazards. The Earth Science Enterprise has three basic activities: a **research** program to increase in our knowledge of the Earth system, an **applications** program to demonstrate practical use of Earth system information to decision-makers in governments, businesses, and elsewhere, and a **technology** program to enable new or lower cost capabilities for the study of the Earth system in the future. NASA's unique capabilities in satellite and suborbital observing systems, information systems, and global models combine to provide the continuing advances in these three areas. This plan, the "NASA Earth Science Enterprise Research Strategy for 2000-2010" describes the strategy that ESE is taking through the new decade for the conduct of its research programs. Separate documents describe the plans for ESE's applications and technology programs, although each will reflect the crucial links between these areas.

The NASA Earth Science program is driven by the recognition of the societal importance of the natural variability of the planetary environment and the realization that humans are no longer passive participants in the evolution of the Earth system, but are instead causing significant changes in atmospheric composition, land use and land cover, water resources, and biodiversity. NASA embraces the concept of "Earth system science" — the idea that the Earth can only be understood as an interactive system that includes the atmosphere, oceans, continents and life. This concept of Earth system science goes far beyond the traditional Earth science disciplines to include a strong focus on interdisciplinary science to understand the interactions between the Earth system components. NASA also clearly recognizes the societal importance of Earth system science, as the scope and pace of natural and human induced changes occurring in the Earth system combine with increasing pressures on land, water, and air resources to increase the demands for accurate environmental information about the present and future.

Earth system science is a highly international and diverse discipline that cannot be studied by a single agency alone. NASA's Earth Science Enterprise is a part of a larger national effort, the multi-agency United States Global Change Research Program (USGCRP) as well as integrated with international scientific activities such as the World Climate Research Program and the International Geosphere-Biosphere Programme. NASA's contributions are the unique vantage point of space, the use of high performance aircraft, innovative remote sensing and in situ measurement techniques, and the development of large-scale data systems and computationally demanding global models designed to assimilate global environmental data and simulate Earth system behavior. NASA's strategy is designed to complement that of other national and international partners, but recognizes that the ESE goals, like those of its counterparts, are to

provide answers to scientific questions and deliver objective scientific information to environmental decision-makers. As such, NASA has an "end-to-end" strategy to assure that all the information, understanding, and capabilities derived from its research programs achieve maximum usefulness to the scientific and decision-making communities. Also, it is important to note that the ESE has a single research program, in which space observations, ground-based and atmospheric in situ observations, laboratory process studies, and computational modeling and data analysis all work together to provide the needed answers and information.

The Earth Science Enterprise has defined its Research Strategy around a hierarchy of scientific questions. At the highest level, the Enterprise is attempting to provide an answer to the one overarching question "**How is the Earth changing and what are the consequences for life on Earth?**" The magnitude and scope of this question are too large to allow a simple answer. The next tier of questions provides a structure constituting the conceptual approach ESE is taking to improve our knowledge of the Earth system.

- *How is the global Earth system changing?*
- *What are the primary forcings of the Earth system?*
- *How does the Earth system respond to natural and human-induced changes?*
- *What are the consequences of change in the Earth system for human civilization?*
- *How well can we predict future changes in the Earth system?*

These five questions define a pathway of "variability, forcing, response, consequence, and prediction" that is taken to further enumerate more specific questions (in Table 1) which provide direction and focus to the program. This structure highlights one of the most important and intellectual challenges of the study of the Earth system — that most responses the Earth system makes to a forcing (either natural or human-induced) can in turn become a forcing factors themselves. This is the definition of a feedback process. Thus, the understanding of feedback processes in the Earth system is central to NASA's study of the Earth system. The third tier of questions refines and delimits the components of and processes within the Earth system of particular interest to ESE.

Hierarchy of Science Questions

Overall: *How is the Earth changing and what are the consequences for life on Earth?*

- How is the global Earth system changing?(Variability)
- How are global precipitation, evaporation, and the cycling of water changing?
- How is the global ocean circulation varying on interannual, decadal, and longer time scales?
- How are global ecosystems changing?
- How is stratospheric ozone changing, as the abundance of ozone-destroying chemicals decreases and new substitutes increases?
- What changes are occurring in the mass of the Earth's ice cover?
- What are the motions of the Earth and the Earth's interior, and what information can be inferred about Earth's internal processes?
- What are the primary forcings of the Earth system? (Forcing)
- What trends in atmospheric constituents and solar radiation are driving global climate?
- What changes are occurring in global land cover and land use, and what are their causes?
- How is the Earth's surface being transformed and how can such information be used to predict future changes?
- How does the Earth system respond to natural and human-induced changes?(Response)
- What are the effects of clouds and surface hydrologic processes on Earth's climate?
- How do ecosystems respond to and affect global environmental change and the carbon cycle?
- How can climate variations induce changes in the global ocean circulation?
- How do stratospheric trace constituents respond to change in climate and atmospheric composition?
- How is global sea level affected by climate change?

- What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?
- What are the consequences of change in the Earth system for human civilization?(Consequences)
- How are variations in local weather, precipitation and water resources related to global climate variation?
- What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?
- What are the consequences of climate and sea level changes and increased human activities on coastal regions?
- How well can we predict future changes in the Earth system? (Prediction)
- How can weather forecast duration and reliability be improved by new space-based observations, data assimilation, and modeling?
- How well can transient climate variations be understood and predicted?
- How well can long-term climatic trends be assessed or predicted?
- How well can future atmospheric chemical impacts on ozone and climate be predicted?
- How well can cycling of carbon through the Earth system be modeled, and how reliable are predictions of future atmospheric concentrations of carbon dioxide and methane by these models?

The scientific breadth of Earth system research is enormous. A brief summary of the subjects considered in each of the five areas identified above follows:

- **Variability:** includes the internal variability of the coupled atmosphere-hydrosphere-biosphere system, with variability ranging from minutes to hours to days to all the way through seasonal, interannual, and longer timescales, as well as trends associated with human-induced changes, especially those occurring at decadal time scales (and longer). Emphasis is on global and large-scale regional variability.
- **Forcing:** includes naturally-occurring forcing factors such as solar irradiance, volcanic eruptions, and land surface evolution, as well as human-induced changes such as increased atmospheric composition of radiatively and chemically active gases and particulates, changes in land use and cover, and changes in availability and quality of water.

- **Response:** includes study of the processes that couple different components of the Earth system and give rise to feedback effects. Particular interest exists in the response of cloud distributions to changes in atmospheric circulation, the response of global ecosystems to changes in temperature, nutrients, and other factors, the atmospheric ozone response to precursors for both its production and destruction, and the response of polar ice to climate change.
- **Consequences:** includes study of local and regional impacts of changes that may be taking place on a global scale, as well as of the possible changes in the extremes of distributions of temperature and precipitation. Work on consequences is carried out through both the research and applications programs. ESE's Applications program pursues demonstration projects applying Earth science, data and technology to areas of resource management, disaster management, community growth, and environmental quality. The ESE Application Strategy (ESE, 2000b) describes this program
- **Prediction:** includes the improvements of environmental predictions, especially those that can accrue from innovative use of new data types provided by ESE. These address issues such as climate and weather on time scales from day-to-day, seasonal, interannual, and decadal, as well as composition of the atmosphere, including pollutants such as ozone and radiatively active gases such as carbon dioxide and methane.

Given the wide range of disciplines and processes that could be productively studied, a number of prioritization criteria are defined to help in selecting and ordering both the specific scientific questions and programs to be implemented. From a scientific perspective, the following criteria are considered to be in descending order of priority, starting with Scientific Return; from the standpoint of implementation, they are listed in ascending order of priority:

- **Scientific Return:** the significance of the expected increase in our fundamental knowledge of some Earth system component or process, especially concerning the reduction of uncertainty, resolution of competing theories, or clear identification of the direction and magnitude of a feedback effect
- **Benefit to Society:** the extent to which the research outcome may be productively utilized on some relevant time scale for greater societal benefit (governmental, economic, individual)
- **Mandated Programs:** some NASA programs, such as the study of stratospheric ozone and continuity of the Landsat program, are required by law. Other activities may be given particular importance in the Federal budget at some point in time.
- **Appropriate for NASA:** the extent to which an activity makes valuable use of the unique capabilities of NASA, and could not be done easily by other governmental or private entities. In many (but not all) cases, questions addressed by NASA take place at large regional to global scales, involve seasonal and longer response periods, and deal with larger impacts than are questions addressed by other agencies.

- **Partnership Opportunity:** the extent to which needed work can be carried out in conjunction with partners, especially (but not exclusively) those of operational agencies in the US and abroad and partner space research agencies around the world.
- **Technology Readiness:** the extent to which current technology enables a question to be productively addressed (and activities implemented). Note that where interest exists and technology does not, investments by ESE's technology program can provide for the needed advances.
- **Program Balance:** to assure overall progress, it is important that resources be distributed in a way that ensures scientific progress is not impeded by the lack of key information about some particular Earth system component or process. This is especially true for improvements in understanding of consequences and capability for prediction, which could be severely limited by lack of understanding of variability, forcing factors, and response mechanisms.
- **Cost:** required resources must be available if a particular question is to be addressed or a mission is to be implemented.

The application of the prioritization criteria to the scientific questions presented allows for prioritization within each category (e.g., variability), but does not permit a linear priority ordering of all the questions. There is a logical progression associated with the research program, in that it is impossible to provide unambiguous answers to questions about consequence and prediction without a knowledge of the variability, forcing, and response processes that underlie them. However, it is not practical to defer all study of consequence and prediction until all uncertainties in the three other areas have been eliminated. The balance among the different areas may differ for different Earth system components or processes, and will evolve over time as the state of knowledge advances. NASA intends to periodically assess its progress on these priorities in consultation with the U.S. National Research Council.

The research program that will address the questions posed in this plan consists of several elements:

- **Basic Research and Data Analysis:** the conceptual source of Earth system science questions and strategies to address them. This part of the program provides the "feedback loop" and assures the results of scientific studies are helping to focus the scientific questions being addressed. It also includes the development of models that are used to integrate piecemeal findings, assimilate observed data and provide the predictive capability needed by ESE.
- **Systematic Measurements:** the long-term (typically but not necessarily continuous) measurement of a select number of critical environmental parameters, typically those that cannot currently be inferred from other parameters. For these measurements, the focus will be on the construction of consistent data sets from multi-instrument, multi-platform, and typically multi-year observations with careful attention to calibration and validation. These typically will involve incremental advances in technology rather than revolutionary

innovations. By the end of this decade, an increasing fraction of these may be obtained from operational entities, as the quality, calibration, and availability of such systems are improved to meet scientific research needs.

- **Exploratory Measurements:** those observations that can yield new scientific breakthroughs by providing comprehensive information about a particular Earth system component or process. These are intended to be pursued for a finite period of time. They are likely to take advantage of innovative, even revolutionary, technologies.
- **Operational Precursor & Technology Demonstration Missions:** projects that aim to demonstrate new instrument and related technologies to either enable a transition to an operational environmental monitoring system, or to achieve a new capability for research. In the former case, such missions will be undertaken where the operational partner agency has a commitment and a plan to use them. Some operational precursor and technology demonstration missions are focused on reducing the cost of making measurements of established importance, while others focus on making measurements not possible or practical previously.
- **Data Management and Distribution:** the vast amounts of data that can be generated by ESE must be archived and distributed in a way to support their easy use by the science and applications communities. Data systems that can facilitate use of data and information, especially those of different types as needed for interdisciplinary science studies, are required.
- **Assessment:** it is important to "complete the cycle" of scientific research and assure that the large body of information obtained by the Enterprise goes through a synthesis process generates new or expanded knowledge of the Earth system. Organized national and international assessments are one essential means of ensuring that appropriate integration of separate findings is actually completed. Assessments support both the basic research and the applications communities, contributing to such major national and international policy and economic decisions. While assessments are important scientifically, they can also be starting components of a broader applications program.

Although the ESE research strategy is laid out in terms of variability, forcing, response, consequence, and prediction, much of its actual implementation will of necessity be carried out in a construct reflective of the components of the Earth system. The approach used most recently by NASA includes five "themes" — biology and biogeochemistry of ecosystems and the global carbon cycle; global water cycle; atmospheric chemistry, aerosols, and solar radiation; oceans and ice in the climate system; and solid Earth science. The first four of these thematic areas are closely aligned with those of the US Global Change Research Program, facilitating coordination of research with other US science agencies. An integrative modeling activity helps bring the individual components together to achieve our Earth system science goals. This approach is implemented with significant attention given to promoting close linkages between the traditional Earth science disciplines; the Earth system science concept has been the driving paradigm of ESE over the past decade, and this conceptual approach will only expand in the coming decade.

NASA's Earth Science Enterprise
Research Strategy
for 2000-2100

http://www.earth.nasa.gov/visions/researchstrat/Chap1_Research_Strategy.htm

APPENDIX B

CONTENTS OF THE ESSP-3 AO LIBRARY

The ESSP-3 AO Library includes documents available from a number of Internet web sites as well as paper copies. Where the same document is available as paper copy and electronically, proposers are requested to access the document electronically unless Internet access is unavailable. Only limited paper copies of documents will be available. Note that not all documents are available in the ESSP-3 AO Library that may be required to develop a proposal. It is the responsibility of the PI to ensure all documents needed are obtained and are the current version.

The ESSP-3 AO Library is accessible on the Internet at the URL address:

<http://essp.larc.nasa.gov/essp>

NASA AGENCY REFERENCES:

1. NASA Strategic Plan
2. NASA Technology Portal
3. NASA Technology Plan

EARTH SCIENCE REFERENCES:

NASA

4. NASA Earth Science Enterprise Website
5. Earth Science Strategic Enterprise Plan
6. Mission to Planet Earth/Earth Observing System Reference Handbook
7. Science Plan for Earth Observing System
8. Report of the Workshop on NASA Earth Science Enterprise Post-2002 Missions
9. Land Cover Land Use Change Program
10. MTPE Commercial Strategy
11. In Situ Observations for the Global Observing Systems
12. Earth Science Integrated Technology Strategy (Currently under review.)
13. NASA Earth Science Enterprise Statement on Data Management

EXTERNAL

14. National Academy of Sciences (1995) A Review of the U.S. Global Change Research Program and NASA's Mission to Planet Earth/Earth Observing System
15. Committee on Environment and National Resources (CENR) Research of the National Science and Technology Council (1996) Our Changing Planet the FY 98 U.S. Global Change Research Program, A Supplement to the President's Fiscal Year 1998 Budget

**TECHNICAL:
SYSTEMS ENGINEERING**

16. NASA Program and Project Management Processes and Requirements (NPG 7120.5)

COMMUNICATION

17. CCSDS Standards

ENVIRONMENTAL TEST REQUIREMENTS

18. General Environmental Verification Specification for STS & ELV Payloads, Subsystems and Components

EDUCATION:

19. ESE Education Strategy - March 1996
20. NASA Implementation Plan for Education 1999 to 2003

LAUNCH SERVICES:

EXPENDABLE LAUNCH VEHICLES (ELVs)

21. Launch Services Risk Mitigation Policy for NASA-Owned Or NASA-Sponsored Payloads
22. Expendable Launch Services for ESSP-3 Announcement of Opportunity

SHUTTLE

23. ESSP Space Shuttle Launch Opportunities
24. Shuttle Small Payloads Project Office
25. Spartan Project
26. Space Shuttle Future Flights

INTERNATIONAL SPACE STATION

27. International Space Station ESSP Research Opportunities
29. SSP52000-IDD-EPP, IDD EXPRESS Pallet
 - SSP52000_IDD_EPP_main.pdf
 - SSP52000_IDD_EPP_app.pdf
 - SSP52000_IDD_EPP_errata.pdf
30. SSP57003, Interface Control Document for Attached Payloads
31. SSP50404, Window Observational Research Facility Block I Project Requirements Document

FEDERAL ACQUISITION REGULATIONS (FAR) ELECTRONIC DOCUMENTS:

32. Federal Acquisitions Regulations (FAR) GENERAL SERVICES ADMINISTRATION
33. NASA FAR Supplement Regulations
34. NASA Financial Management Manual

GENERAL REFERENCE INFORMATION:

35. EOSDIS Information
36. NASA's Mission Operations and Communication Services (SOMO)
37. Generic Contract Terms and Conditions for ESSP Missions (Educational Institution)

38. Generic Contract Terms and Conditions for ESSP Missions (Commercial Organizations)
39. Earth Science Systems Program Library (MTPE Library) (Information ONLY, no documents are available from this site)
40. Mission Definition and Requirements Agreement - Example
41. Elements to be included in arrangements between U.S. Principal Investigators and cooperating foreign parties under the ESSP Program
42. ESSP Mission Confirmation Plan
43. Examples of Education and Public Outreach Activities
44. U.S. Accredited Post Secondary Minority Institutions
45. Basics of Space Flight
46. Access to Space

RELIABILITY AND QUALITY ASSURANCE, MATERIALS AND EEE PARTS:

47. SMEX Safety, Reliability, and Quality Assurance Requirements. Describes the responsibilities of the PI with regard to Safety, Reliability, and Quality Assurance.
 - NSTS System Safety Milestones and Process Flow. For those PI's intending to use the Space Shuttle, a reference for the development of their system safety plans and associated cost estimates.
 - ELV System Safety Milestones and Process Flow. For those PI's intending to utilize Expendable Launch Vehicles, a reference for the development of their system safety plans and associated cost estimates.
48. NASA/GSFC Office of Systems Safety and Mission Assurance
49. NASA Technical Standards
 - NASA Technical Standard NASA-STD-8739.3, Soldered Electrical Connections
 - NASA Technical Standard NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring
 - STD-8739.1, Workmanship Standard for Staking and Conformal Coating of Printing Wiring Boards and Electronic Assemblies
 - NASA Technical Standard NASA-STD-8739.7, Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)
 - NASA Technical Standard NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation
 - STD9739.2, Workmanship Standard for Surface Mount Technology
 - ANSI/IPC-D-275 Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies, Class 3 (Not Currently Available Electronically)
 - IPC 6011 and IPC 6012, Class 3 as the basic specification requirements with GSFC S-312-P-003B, Procurement Specification for Rigid Printed Wiring Boards for Space Applications and other High Reliability Uses as a supplement (Not Currently Available Electronically)
50. Earth Explorers Mission Assurance

SAFETY:

51. NASA Office of Safety & Mission Assurance
52. Risk Management
53. Software IV & V

54. NSTS 1700.7B, "Safety Policy and Requirements for Payloads Using the Space Transportation System"
55. 45 SPW S-100/KHB 1700.7C, "Space Shuttle Payload Ground Safety Handbook" (Document does not include Appendices)
56. ERR 127-1 (1997), "Eastern and Western Range Safety Requirements"
57. NPD 8710.3 NASA Policy For Limiting Orbital Debris Generation
58. NSS 1740.14 Guidelines and Assessment Procedures for Limiting Orbital Debris
59. RSM-93, "Range Safety Manual for Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF)"
60. "Range Safety Project Support Process"
61. "Flight Safety Process"
62. "Ground Safety Process"
63. (SSD TD-0005) (currently Rev B), "Pegasus Design Safety Requirements Document" (Not Currently Available Electronically)
64. SSD TD-0018) (currently Rev A), "Pegasus Safety Requirements Document for Ground Operations" (Not Currently Available Electronically)
65. Earth Explorers Safety Requirements (Also contained in Appendix J)

OTHER NASA SERVICES:

66. NASA Space Operations Mission Office (SOMO)
67. Rapid Spacecraft Development Office (RSDO)

ISO 9000 Series:

The following ISO 9000 quality documents describe current national and NASA standards of quality processes and procedures.

Note: The first three ISO 9000-related documents are copyrighted and cannot be reproduced without appropriate compensation. For copies contact:

American Society for Quality Control (ASQ)
611 East Wisconsin Ave.
P.O. Box 3005
Milwaukee, WI 53201-3005

1-800-248-1946 or 414-272-8575, fax 414-272-1734

68. American National Standard, "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing", ANSI/ASQC Q9001-1994.
69. "Quality Management and Quality System Elements - Guidelines", ANSI/ASQC Q9004-1-1994.
70. "Quality Management and Quality Assurance Standards - Guidelines for Selection and Use", ANSI/ASQC Q9000-1-1994.
71. "NPD 8730.3 NASA Quality Management System Policy (ISO 9000)"

APPENDIX C

LAUNCH SERVICES COST TABLE

This information can be found in the ESSP-3 AO Library “Expendable Launch Services for ESSP-3 Announcement of Opportunity” at the following URL.

<http://essp.larc.nasa.gov/essp>

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APPENDIX D

MISSION CONFIRMATION REVIEW PROCESS

Note: This Appendix to the ESSP AO describes the general Mission Configuration Review process for Earth Explorers at the NASA Goddard Space Flight Center, and is representative of the process at other NASA Centers. In accordance with NASA's plan to transfer program management responsibility to the Field Centers and designate Lead Centers for multi-center programs, Goddard Space Flight Center is assigned the Lead Center responsibility for Earth Explorers Projects, including the Earth Systems Science Pathfinder (ESSP). As Lead Center, Goddard will be responsible for establishing and tracking program metrics and for reporting program status and progress to NASA Headquarters.

A formal Confirmation Review process is required for all Earth Explorers Program missions. These missions are either directed by the Earth Science Enterprise based on national priorities or, solicited and selected through an Announcement of Opportunity (AO) such as Earth System Science Pathfinder (ESSP) or the University Earth System Science (UnESS). The purpose of this process is to establish that the project team has completed a credible and acceptable mission formulation subprocess and is prepared to proceed with the implementation subprocess to complete the flight and ground system development and mission operations within the identified cost and schedule constraints for the mission.

A Mission Design Review (MDR) is typically held toward the end of the definition phase of the formulation subprocess, but prior to the initiation of full-scale flight hardware/software development. The MDR Panel will be co-chaired by an independent expert (appointed by the GSFC Earth Explorers Program Office), and typically a technical co-chair from the GSFC System Review Office (SRO). The Earth Explorers Program Office and the co-chairs will select review panel members to assess the maturity of the mission, program status and ability to meet program commitments. The findings from the MDR are then presented to the GSFC Governing Program Management Council (GPMC) at a Confirmation Readiness Review (CRR) for consideration resulting in recommendations on mission confirmation. These recommendations are presented to the Associate Administrator (AA), Office of Earth Science (OES), at a Mission Confirmation Review (MCR). The AA has final approval authority on mission confirmation. Approval of mission confirmation constitutes direction to begin the mission implementation subprocess.

1.0 Introduction

1.1 Objective

The objective of the Earth Explorers Program Office Mission Confirmation process is to provide the Earth Explorers Program Office, the GPMC and the Office of Earth Science with an independent assessment of mission readiness to proceed with the Implementation Subprocess, by identifying the technical, financial, and management risks associated with mission development

and operations, and suggesting action to reduce or mitigate the risks. The products of this process will be:

- A presentation of the findings of the MDR given to the Earth Explorers Program Manager, the mission Project Manager and the Principal Investigator (PI) for feedback and resolution of outstanding actions. The criteria for this review are defined in this plan.
- A formal presentation of the findings of the MDR, and project responses to the findings, to the GPMC at a Confirmation Readiness Review (CRR). Based on the MDR findings and project responses the GPMC will develop recommendations on mission confirmation to be presented to the AA, OES, at a MCR.

1.2 Scope

The Earth Explorers Mission Confirmation process will assess the complete life cycle of the mission. Areas that will undergo review include but are not limited to system designs (hardware and software), deliverable science data products, launch vehicle interface, and mission operations, and the overall technical readiness of the mission. Management, design, manufacturing, product assurance, test plans and test facilities are also included in the scope of the assessment. In summary, the review will focus on the mission's ability to meet technical, cost and schedule commitments.

1.3 Ground Rules

- a) The Mission Design Review Panel will consist of experts from appropriate disciplines who are independent of the mission being reviewed.
- b) The Mission Design Review Panel deliberations may be conducted in closed session at the discretion of the Chairperson.
- c) The mission requirements are defined in the Mission Level 1 Requirements Document. The panel will assess the mission based on the ability to deliver the science data as defined in the above document.

2.0 Mission Design Review

2.1 Mission Design Review Organization

The MDR panel is led by the Co-Chairs, who will coordinate with the Project/Mission Manager to ensure that the team has access to sufficient information to accomplish its objectives with a minimum impact to the mission. They will coordinate the review panel activities and present the findings. The team members are selected by the Co-Chairs and are approved by the Earth Explorers Program Office.

2.2 Review Process

The Mission Design Review typically will be held over a 2-3 day period at GSFC or a suitable mission team site. The panel will meet at the conclusion of each day to discuss the results of the day's presentations and develop the preliminary findings and recommendations. At these sessions, panel members should be prepared to brief the MDR Co-Chairs on their findings for their assigned area. The individual briefings will then be integrated into comprehensive findings of the panel. At the conclusion of the review, each member will provide the Co-Chairs with a summary of their findings, as well as any specific action items or recommendations they have identified. The Co-Chairs will brief the Principal Investigator, Project/Mission Manager and the Earth Explorers Program Manager on the review panel findings at this time. The PI, project manager and their mission team will develop responses to the panel findings, which will be coordinated with the MDR Co-Chairs. The Principal Investigator, Project/Mission Manager, the MDR Co-Chairs and the Earth Explorers Program Office will then present the findings, recommendations and responses to the Goddard Program Management Council at the CRR for recommendations for proceeding into the mission implementation subprocess. The GPMC will present their recommendation to the Office of Earth Science Associate Administrator for approval. In order to minimize the impact on the mission schedule, the entire confirmation process should be completed within two months.

2.3 Nominal Schedule

Mission Design Review	Duration of 2-3 days
Panel members' report due to Chairperson	At conclusion of MDR
Panel brief to PI/Project/Earth Explorers	At conclusion of MDR
PI/Project Team Response	Within 3 weeks after MDR
GPMC Confirmation Readiness Review	Within 4 weeks after MDR
ESE Mission Confirmation Review	Within 2 weeks after CRR

3.0 Success Criteria

3.1 Science and Technical Evaluation

1. Does the Mission, Spacecraft and Instrument Design, as presented, reflect a level of maturity that meets the mission science requirements?

Scope of Criteria 1 - Indicator questions

What are the mission science requirements? How have requirements been allocated to each mission element, e.g., spacecraft, instrument, and ground system? What is the status of requirement allocations to subsystems of each element?

What is the status of the hardware being developed for the mission? What has affected the hardware development since mission selection? What critical activities (design, tests, etc.) remain to assure the hardware can be included in the mission?

What are the technical metrics used by the project? What is the status and trend of each?

What are the results of analyses, tests and design activities related to the hardware developments?

What system trades have been completed? What are the remaining trade studies that must be completed?

What is the specific design and/or flight heritage of the spacecraft systems and instruments?

What is the status of the primary interfaces, e.g., instrument to spacecraft, spacecraft to launch vehicle, and spacecraft to ground? What design, test, and integration tasks are allocated to NASA, or other government agencies?

What is the status of the software development? How has software been estimated for each element and subsystem? How have margins been allocated to accommodate any technologies affecting the software?

What validation/calibration is needed/planned prior to launch to ensure science objectives are met? What is the science validation plan during operations? What critical data are needed during operations and how are the data to be captured?

What is the descope plan and what are the milestones for descope? What are potential mass, power, and software impacts for each descope option? Has the project quantified the potential impacts?

What are the cost and schedule impacts/improvements for each descope option? What is the impact of each descope option on the mission science deliverables?

What is the test and integration plan for the project?

What is the mission operations concept?

What is the ground system architecture?

3.2 Management Structure and Composition Evaluation

2. Are the Management Processes used by the Mission Team sufficient to develop and operate the Mission?

Scope of Criteria 2 - Indicator questions

What is the systems engineering management approach?

Are the roles and responsibilities of each organization clearly defined? What is the experience of key project personnel in each organization? What processes are in place for making, communicating and implementing project decisions? What project management system, in place or planned, is used to track the status of each task and its deliverables?

Is there a common cost/schedule reporting system being utilized across the project?

What is the risk identification and mitigation process? What risks have been identified? What are the mitigation plans?

What is the process for managing and implementing mission descopes? Who has approval authority for implementing descopes?

What is the critical path and how is it being routinely assessed and managed?

Is the WBS complete with all deliverables defined? Is there an intersite delivery plan or matrix?

What is the plan for manufacturing the spacecraft and instruments? What are the critical long lead parts or material? What is the long lead procurement status? Have all required facilities been identified and utilization planning developed? Are agreements in place for use of facilities for testing? What is the schedule flexibility?

What oversight/insight is the program office exercising on all elements? How and to what tasks have program office civil servant resources been allocated to supplement developments?

What process changes are being made to minimize the development time and cost (smaller, faster, cheaper)?

3.3 Cost and Schedule Evaluation

3. Do the cost estimates, control processes and schedules indicate the mission will be ready to launch on time and within budget?

Scope of Criteria 3 - Indicator questions

What is included in the project budget and what is covered elsewhere?

For items covered outside the project budget, is there sufficient funding planned? Could the project cover shortfalls for these items with project budget?

How does the current cost estimate and burn-rate compare to the baseline? Does the cost analysis indicate the mission will stay within the project budget?

What cost and schedule monitoring and control processes are in place? How is progress being measured? How are reserves allocated and released? Is there sufficient reserve in cost and schedule to complete the mission by the planned launch date?

What incentives are in place to control cost and schedule? How are the program cost caps reflected in contracts and allocated?

APPENDIX E

REGULATIONS GOVERNING PROCUREMENT OF FOREIGN GOODS OR SERVICES

The following Federal Acquisition Regulation (FAR) clauses apply to the purchase of foreign goods and services and may be included in contracts resulting from this Announcement of Opportunity:

FAR 52.225-1	Buy American Certificate (Dec 1989)
FAR 52.225-3	Buy American Act -- Supplies (Jan 1994)
FAR 52.225-7	Balance of Payments Program (Apr 1984)
FAR 52.225-8	Buy American Act -- Trade Agreements -- Balance of Payments Program Certificate (Jan 1994)
FAR 52.225-9	Buy American Act -- Trade Agreements -- Balance of Payments Program (Jan 1994)
FAR 52.225-10	Duty-Free Entry (Apr 1984)
FAR 52.225-11	Restrictions on Certain Foreign Purchases (Aug 1998)
FAR 52.225-18	European Union Sanction for End Products (Jan 1996)
FAR 52.225-19	European Union Sanction for Services (Jan 1996)
FAR 52.225-21	Buy American Act -- North American Free Trade Agreement Implementation Act -- Balance of Payments Program (Jan 1997)

The Proposer is directed to the Federal Acquisition Regulation for further information on these regulations.

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APPENDIX F

ELEMENTS TO BE INCLUDED IN ARRANGEMENTS BETWEEN U.S. PROPOSAL TEAM LEADERS AND COOPERATING FOREIGN PARTIES

The following elements shall be included in arrangements between the proposing team leader and foreign parties contributing to or cooperating in activities under the Earth System Science Pathfinder (ESSP) Announcement of Opportunity.

SCIENCE DATA RIGHTS

Unless otherwise agreed between NASA and the selected ESSP proposal Principal Investigator, all science data resulting from this cooperative activity will be made available to all users without restriction at no more than the cost of dissemination, through appropriate data archives in the United States and [foreign country]. In the event that reports or publications based upon this data are copyrighted, the parties and NASA shall have a right under the copyright to reproduce, prepare derivative works from, perform, display, and distribute copies of such copyrighted work for their own purposes royalty-free. If data resulting from missions have commercial value, data information rights and policies must be negotiated with NASA on a case-by-case basis.

TRANSFER OF GOODS AND TECHNICAL DATA

The parties are obligated to transfer only those technical data (including software) and goods necessary to fulfill their respective responsibilities under this agreement, in accordance with the following provisions:

1. The transfer of technical data for the purpose of discharging the parties' responsibilities with regard to interface, integration, and safety shall normally be made without restriction, except as required by national laws and regulations relating to export control or the control of classified data. If design, manufacturing, and processing data and associated software, which is proprietary but not export controlled, is necessary for interface, integration, or safety purposes, the transfer shall be made and the data and associated software shall be appropriately marked. Nothing in this article requires the parties to transfer goods or technical data contrary to national laws and regulations relating to export control or control of classified data.
1. All transfers of proprietary technical data and export-controlled goods and technical data are subject to the following provisions. In the event a Party finds it necessary to transfer goods which are subject to export control or technical data which is proprietary or subject to export controls, and for which protection is to be maintained, such goods shall be specifically identified and such technical data shall be marked with a notice to indicate that they shall be used and disclosed by the receiving Party and its related entities (e.g., contractors and subcontractors) only for the purposes of fulfilling the receiving Party's responsibilities under

the programs implemented by this Agreement, and that the identified goods and marked technical data shall not be disclosed or retransferred to any other entity without the prior written permission of the furnishing Party. The receiving Party agrees to abide by the terms of the notice, and to protect any such identified goods and marked technical data from unauthorized use and disclosure, and also agrees to obtain these same obligations from its related entities prior to the transfer.

1. All goods, marked proprietary data, and marked or unmarked technical data subject to export control, which are transferred under this Agreement, shall be used by the receiving Party exclusively for the purposes of the programs implemented by this Agreement.

LIABILITY

If the successful proposing team has elements of foreign cooperative activity, a cross-waiver of liability may be required at the appropriate time.

APPENDIX G

EARTH SCIENCE ENTERPRISE (ESE) DATA AND INFORMATION SYSTEMS AND SERVICES INTERFACES AND STANDARDS

NASA ESE Data Policy

NASA ESE requires PI's to adhere to a principle of full and open access to ESE data products; that is, NASA is committed to the full and open sharing of Earth Science data obtained from U.S. Government-funded and -owned systems with all users as soon as such data become available, except as discussed in Section 3.2.3. ESSP PI's selected as a result of this AO are required to make their level 1 and higher-level data products available to the general public in a timely manner. The ESE Data Policy is available at <http://www.earth.nasa.gov/visions/data-policy.html>.

Earth Science Enterprise Required Interfaces

ESSP PI's are required to publicize their products and data services to the broader Earth Science community via the Global Change Master Directory (GCMD). PI's will ensure population of the GCMD with appropriate information on their instrument and data products and services, and provide pointers to their World Wide Web (WWW) page or other client interface for search and access. All data set descriptions shall be provided as Directory Interchange Format (DIF) entries, which are automatically compliant with the Federal Geographic Data Committee (FGDC) standard for geospatial data. The content for DIFs can be easily submitted through the DIFbuilder tool, available at <http://gcmd.nasa.gov/difbuilder>. Descriptions for related data tools or services shall be provided as Services Entry Record File (SERF) entries, for which the content can be submitted through the SERF builder tool, available at <http://gcmd.nasa.gov/serfbuilder>. Contact the GCMD User Support Office at <http://gcmd.nasa.gov/> for assistance.

Data Archival and Access

Adequate funds shall be included in the proposal for all data set development activities, including production, management, distribution, complete documentation of the data set and supporting peer-reviewed articles, and to ensure the smooth transition to final archival disposition.

The proposal shall describe the science information system that will provide the active archive during the ESSP mission phase, including a complete description of the products and the methodology for their full and open provision.

For data archive and distribution, ESSP PI's may decide to partner with one of the NASA Data Centers in the Distributed Active Archival Center (DAAC) Alliance, or a designated Long Term

Archive (LTA) site at NOAA or USGS, as appropriate. The DAAC Alliance Data Centers are described in the web site at: <http://nasadaacs.eos.nasa.gov/>.

NASA presently works with a Federation of Earth Science Information Partners (ESIPs), which includes the DAACs. ESSP PI's are encouraged to investigate the ESIP Federation if an alternate arrangement than provision of data through a DAAC Alliance data center is envisioned. More information on the ESIP Federation can be found at <http://www.esipfed.org/>.

ESSP PI's are required to archive their basic data (typically Level 1 data) at one of the NASA DAAC Alliance data centers or at an LTA site. If the PI plans for an alternate arrangement for mission phase data archive and dissemination, the proposer shall make, and include in the proposal, a transition agreement with an appropriate DAAC Alliance or LTA center to ensure the smooth transition to post-mission archival disposition. Each data set shall be accompanied with clear, comprehensive, and concise documentation so that specialists and non-specialists alike will be able to understand how the data can be used.

Data and Metadata Standards

To facilitate access to ESSP data by the Earth Science community, it is recommended that ESSP missions produce data products in a core NASA-provided or community-endorsed format compatible with the research community that will utilize the data, and that the missions generate and store metadata describing their data products that will facilitate user search and order, and user understanding of product quality and utility.

The present EOS missions standards being utilized at four DAACs are the HDF-EOS (hierarchical data format) standard data format and metadata that conforms to the intermediate level of the EOSDIS Core System (ECS) Metadata Standard. Information on HDF-EOS and the ECS Metadata Standard is provided below. The proposed partner DAAC can also provide appropriate DAAC-unique NASA-provided standards and interfaces. If a PI proposes to use other methods or standards for data product and metadata, then the approach and rationale shall be provided. All such costs for data production, management and distribution, including DAAC costs, shall be included in the cost proposal.

The HDF-EOS Primer, HDF-EOS Specification, and HDF-EOS Application Program Interfaces may be located via the WWW at <http://hdfeos.gsfc.nasa.gov/hdfeos/workshop.html>. Software for producing HDF-EOS data, serving HDF-EOS data on the WWW, and visualizing HDF-EOS data is also referenced at this Web page.

Adherence to the intermediate level of the ECS Metadata standard will result in the creation of directory, inventory and guide level information compatible with EOSDIS Version 0 data standards and facilitate future interoperability with EOSDIS Version 0 and ECS-based versions. The ECS "Release 6A Implementation Earth Science Data Model 420-TP-022-001" may be located via the WWW at <http://edhs1.gsfc.nasa.gov/>.

ESIP Federation members support a multi-faceted System Wide Interface Layer (SWIL) which conforms to DAAC Alliance Standards. A primary component of the SWIL is the GCMD, to

which all ESIP PI's submit DIFs and SERFs as described above. Many ESIPs also support the EOSDIS V0 Information Management System with data inventory information for search and order functionality. Another important component of the SWIL is the Mercury search system. Using WWW documents and protocols, Mercury combines DIFs, web pages and other documents, optional data inventory listings, and optional service listings in a single catalog organized by data set. Federation members are also exploring data access interoperability through emerging community systems.

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APPENDIX H

MISSION ASSURANCE GUIDELINES AND REQUIREMENTS

Note: This Appendix to the ESSP AO describes the general Mission Assurance Guidelines and Requirements for Earth Explorers at the NASA Goddard Space Flight Center, and is representative of the guidelines and requirements at other NASA Centers. In accordance with NASA's plan to transfer program management responsibility to the Field Centers and designate Lead Centers for multi-center programs, Goddard Space Flight Center is assigned the Lead Center responsibility for Earth Explorers Projects, including the Earth Systems Science Pathfinder (ESSP). As Lead Center, Goddard will be responsible for establishing and tracking program metrics and for reporting program status and progress to NASA Headquarters.

PREFACE

The purpose of this document is to serve as a set of requirements and guidelines to the Project/Mission Team in preparing an appropriate mission assurance program and its implementation. Each section of this document contains requirements and a series of guidelines for implementing mission assurance in accordance with the Earth Explorers Program. The guidelines may be tailored to meet the specific needs of each mission, but this tailoring shall be reviewed and accepted by the Earth Explorers Program Office and must meet the intent of the requirements. Each Earth Explorers project/mission is required to be implemented in accordance with the aerospace industry best practices for mission assurance, as they apply to that particular mission.

1.0 Overview

It is the responsibility of the Project/Mission Team to plan and implement a comprehensive Mission Assurance program for all flight and ground hardware, software, Ground Support Equipment (GSE), and mission operations. This responsibility extends to all of the mission subcontracts and suppliers. Mission assurance insight is planned by the Earth Explorers Program Office and shall be focused primarily on those activities that contribute most to product integrity. Deliverable documentation may be reduced, provided the mission team maintains an adequate internal record keeping system that provides the necessary traceability to the Earth Explorers Program Office and that is documented in a Mission Assurance Plan. The Earth Explorers Program Office shall support and participate with the mission team in assuring that the mission assurance program being implemented is valid, complete, and effective. The Earth Explorers Program Office is prepared to assist the mission team in any aspect of mission assurance, and to be the mission team's point-of-contact for ready and regular access to the Goddard Space Flight Center's mission assurance expertise.

Earth Explorers missions that are predominately “single string” systems with emphasis on simplicity of design and cost control require a rigorous and disciplined systems engineering effort. Utilization of quality parts and materials and high standards of workmanship, have allowed a limited reliability and quality assurance program, guarded by the test program, to achieve the adequate reliability and mission success. It is recommended that each mission team consider similar approaches that envelope all aspects of the mission development. A philosophy based on hurried design and development, followed by an extensive test and repair program, has been shown to be a costly and unreliable approach.

An agreement between the mission team and the Earth Explorers Program Office on the quality assurance, reviews, safety, design assurance and verification system to be implemented shall be required prior to the confirmation of the mission and shall be documented in a Mission Assurance Plan. This plan is required for review by the Earth Explorers Program Office prior to the agreement. The plan may be developed during a mission study, if one is planned, or during the formulation phase.

2.0 Mission Assurance

2.1 Quality System

The Project/Mission Team shall define and implement a quality system based on ANSI/ASQC Q9001-1994 that meets the intent of ISO 9001. The Project/Mission Team’s quality system shall encompass all flight and ground hardware, flight software and ground support equipment development, as well as mission operations.

2.2 Workmanship

The Project/Mission Team shall impose workmanship standards, which help assure that the required mission lifetime and performance are met. The following commercial or NASA workmanship standards are given as guidelines and shall be considered for use:

Soldering of Electrical Connections: NASA Technical Standard NASA-STD-8739.3, Soldered Electrical Connections

Cabling, Harnessing, and Crimping: NASA Technical Standard NASA-STD-8739.4, Crimping, Interconnecting Cables, Harnesses, and Wiring. Note: MIL-STD-1130B, Connections, Electrical, Solderless Wrapped can be used if the missions are planning to use wire wrap for flight hardware or mission critical ground support equipment.

Conformal Coating and Staking: NAS 5300.4(3J-1), Workmanship Standard for Staking and Conformal Coating of Printed Wiring Boards and Electronic Assemblies

ESD Control: NASA Technical Standard NASA-STD-8739.7, Electrostatic Discharge Control (Excluding Electrically Initiated Explosive Devices)

Surface Mount Technology (SMT): NHS 5300.4 (3M), Workmanship Standard for Surface Mount Technology.

Note: SMT processes must be qualified to the mission profile and life expectancy of the mission.

Printed Wiring Board Design: ANSI/IPC-D-275, Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies, Class 3

Printed Wiring Board Procurement: IPC 6011 and IPC 6012, Class 3 as the basic specification requirements with GSFC S-312-P-003B, Procurement Specification for Rigid Printed Wiring Boards for Space Applications and other High Reliability Uses as a supplement.

The Project/Mission Team and their subcontractors shall provide printed wiring board coupons to GSFC, or to a GSFC approved laboratory, for test, analysis and review.

Fiber Optic: NASA Technical Standard NASA-STD-8739.5, Fiber Optic Terminations, Cable Assemblies, and Installation

Use of other workmanship standards (e.g., MIL-STD, IEEE, IPC, ISO, ANSI, etc.) shall be permitted with the concurrence of the Earth Explorers Program Office.

2.3 Failure Reporting

A documented Failure Reporting System shall be implemented. A problem/failure report shall be written for any departure from design, performance, testing, or handling requirement that affects the function of flight equipment, or ground support equipment that interfaces with flight equipment, or that could compromise mission objectives.

Reporting of failures to the Earth Explorers Program Office shall begin with the first power application at the box, instrument, or spacecraft levels. This reporting shall continue through formal acceptance of the hardware. For software problems, failure reporting shall begin with formal qualification testing of each computer software configuration item or first use of the computer software configuration item with the flight hardware. All failure reporting records shall be submitted to the Earth Explorers System Assurance Manager for information. Either paper or electronic format is acceptable. The Project/Mission Team can use any failure report format they deem acceptable, as long as the Earth Explorers Program Office has concurred with the format. The Project/Mission Team shall maintain failure-reporting records of problems encountered at the lower levels of assembly for information.

3.0 Reviews

The implementation of the mission shall be periodically reviewed by a competent and independent assessment team or teams of experts, to assure that satisfactory progress is being made toward meeting mission requirements.

All system level reviews (see Section 3.1) shall be conducted by GSFC personnel. These reviews shall concentrate on the critical system and end-to-end technical and programmatic aspects of the mission. Additional reviews at the subsystem and system levels shall be conducted by the Project/Mission Team to ensure a detailed examination of the project/mission. The review plan shall thoroughly examine subsystem designs and their interfaces during the formulation subprocess in order to mitigate risk and resolve potential problems without major impact to the project/mission. It shall provide a continual examination of the technical and programmatic progress throughout the implementation subprocess as an ongoing means to reduce risk, address issues and resolve problems to further ensure mission success. If requested through the Earth Explorers Program Office, the GSFC shall provide technical expertise for participation in these additional reviews. The GSFC is required to assess the thoroughness, competence and independence of the total review process and shall be invited to send representatives to all technical reviews.

A Confirmation Review Process shall also be conducted. These reviews may be coordinated with the Project/Mission Team so that they coincide with other reviews. It is the Project/Mission Team's responsibility to address all concerns and action items identified during these reviews.

3.1 System Reviews

The required reviews for Earth Explorers projects/missions are the System Requirements Review (SRR), Preliminary Design Review (PDR), Mission Design Review (MDR), Confirmation Readiness Review (CRR), Mission Confirmation Review (MCR), Critical Design Review (CDR), Pre- Environmental Review (PER), Pre-Ship/Operational Readiness Review (PSR/ORR), Mission Readiness Review (MRR), and Flight Readiness Review (FRR). Each review chairman, in concert with the Earth Explorers Program Office and GSFC directorates, appoints independent key technical experts as review team members. The Chief Systems Engineer for the Earth Explorers Program Office or his designee shall be a review team member for each of these reviews. Every effort will be made to maintain continuity of the chairman and the key technical experts for the duration of the mission. Other experts shall be added to and/or deleted from the review team, according to the technical needs and phase of the mission. The scope and function of these required reviews is as follows:

System Requirements Review (SRR): The SRR shall be the first major mission review during the Formulation Subprocess. The purpose of this review is to formally examine the agreed-to mission science, operations and technical requirements. Traceability of these requirements shall be demonstrated. The SRR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Preliminary Design Review (PDR): The PDR shall occur during the Formulation Subprocess, but after final definition of the mission science and technical requirements. The purpose of the PDR is to examine preliminary designs of all mission subsystem and system components for technical feasibility with respect to the mission requirements and to assess the mission design at the subsystem and system levels as it relates to the mission requirements. The PDR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Mission Design Review (MDR): The MDR shall be held at the end of the mission Formulation Subprocess and shall follow the PDR or be combined with the PDR. It combines the technical findings of the PDR with a programmatic and process review of the proposed mission implementation. The purpose of this review is to confirm:

- final design, fabrication and test plans for each subsystem
- final interface control documents
- mission integration and verification plans
- complete programmatic plan through launch
- requirements flow-down traceability
- risk identification and mitigation plans, including descopes
- comprehensive cost, schedule and resource plans
- complete ground system architecture
- comprehensive system engineering plan
- final definition of mission science requirements
- thoroughly defined roles and responsibilities of all mission team members

The GSFC Systems Review Office, Code 301 and an appointee of the Earth Explorers Program Office shall co-chair the MDR.

Confirmation Readiness Review (CRR): The CRR shall be held after the MDR and is the Earth Explorers program gate for mission approval to proceed into the Implementation Subprocess. The findings from the MDR are presented to the GSFC Governing Program Management Council (GPMC) for consideration and subsequent project/mission confirmation. The results from this review are either Mission Confirmation or conditional Mission Confirmation pending action item closure or Mission Termination.

Mission Confirmation Review (MCR): The GSFC PMC Chair and the Explorers Program Office present the results and recommendations of the CRR to the Associate Administrator, Office of Earth Science for concurrence and final approval for the mission to proceed into the Implementation Subprocess.

Critical Design Review (CDR): The CDR should occur after the design has been completed, but prior to the start of flight hardware manufacturing or coding of the flight software. It shall emphasize implementations of design approaches, mission operations planning, as well as test planning for all flight systems. In the case of long lead procurements, manufacturing may be initiated prior to CDR, if approved by the Earth Explorers Program Office, as required to meet schedule. The CDR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Pre-Environmental Review (PER): The PER shall assess the readiness of the flight hardware, software and required environmental test facilities to begin acceptance testing. The PER shall also cover:

- design changes since CDR
- status of nonconformances
- test documentation (plans, procedures, waivers) and facilities readiness

- hardware and software configuration
- mission operations status

The PER shall be held prior to the full system integration and functional test in preparation for environmental testing. The PER shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Pre-Ship Review/Operational Readiness Review (PSR/ORR): The mission PSR is conducted at the end of the mission Implementation Subprocess. The mission PSR shall verify that all system elements meet the requirements of the mission and are ready to proceed into final launch preparations. The mission PSR shall verify that testing has been completed with no unacceptable open issues and to validate the readiness of the flight hardware and software and ground system. Included as part of the above review is the Operations Readiness Review (ORR). This part of the review shall assess the readiness, and document the final details of the approach agreed to be used for flight operations. The mission PSR/ORR shall at a minimum, cover:

- determination of completion of testing flight hardware and software
- verification of system requirements
- verification and documentation of final hardware and software configuration
- identification and status of outstanding safety risks
- disposition of waivers, deviations, open issues
- results of compatibility testing of spacecraft and ground support equipment
- results of end-to-end system level testing and verification
- orbital operations plans
- mission operations, ground system and data processing system readiness
- launch system readiness (interfaces, vehicle)
- evaluation of the acceptance data packages

The result of this review shall be reported at the Mission Readiness Review. The mission operations agreement reached at the ORR cannot be changed without NASA concurrence. The PSR shall be chaired or co-chaired by the GSFC Systems Review Office, Code 301.

Mission Readiness Review (MRR): The MRR is typically held 4-6 weeks prior to launch. The review shall cover all components of mission readiness; project status, science objectives and mission performance, instrument readiness, spacecraft readiness, ground system readiness, launch service readiness and launch site assessment, resolution of all open items, liens and waivers, public affairs plan and other topics as appropriate to ensure all aspects critical to mission success have been reviewed. The MRR is presented to the GSFC Governing Program Management Council (GPMC) for review and certification of the readiness of all mission components to proceed toward launch. The results of the MRR are presented to the Associate Administrator, Office of Earth Science.

Flight Readiness Review (FRR): The FRR shall take place at the launch site just prior to launch. This review is to certify final flight readiness of all mission elements. All open issues from the MRR must be resolved before the FRR.

The GSFC Systems Review Office, Code 301, shall chair the FRR.

3.2 Peer Reviews

The Project/Mission Team shall focus resources on engineering working-level reviews (peer reviews) throughout the mission formulation and implementation subprocesses to identify and resolve concerns prior to formal, system level reviews. Engineering peer reviews are required and typically occur during all phases of the project life cycle. These reviews are expected to present more detail than system-level formal reviews. Peer review is defined as a detailed independent engineering design review focused at the Subsystem and box level, conducted informally with recognized internal or external experts having current detailed knowledge of the design specialties associated with the item under review. Primary design documentation, such as drawings, schematics, wiring diagrams, and analyses are the review vehicles. Its purpose is to substantiate a detailed understanding of the design's ability to meet all of its performance and interface requirements, to surface correctable problems early, and to ensure best known practices are used that enhance robustness by avoiding known or predictable problems.

The intent of the peer reviews is to have participants gain a detailed understanding of component and subsystem design and assess the ability to meet higher level system and mission requirements. Effective peer reviews will enable the content of higher level formal reviews described in Section 3.1 to be significantly streamlined.

For each review a written record shall be kept of time, place, and attendees. Timely, accurate insight, through action item documentation and follow-up activities, is vital to the process. The Project/Mission Team's quality system shall track and close-out all actions items identified during these peer reviews to ensure that issues are resolved promptly, at the lowest levels and before system level reviews. A list of action items and responses or closure plans from each peer review shall be maintained by the Project/Mission Team's quality system and shall be made available to the Earth Explorers Program Office at least one week prior to the subsequent system-level formal review. The results of the peer reviews and all open action items with closure plans shall be presented at the system-level formal review.

To promote continuity of the entire review program, the Systems Review Office and the Earth Explorers Program Office shall be invited to attend and participate in any peer review session held by the Project/Mission Team. Upon request, the program office can supply technical expertise as required for participation in the areas undergoing peer reviews.

Some of the topics that shall be addressed in the peer reviews are as follows:

- interface control design verification
- parts and materials review
- analysis and studies
- safety issues
- risk assessment, resolution and contingency plans
- procurements
- confirmation of technology items
- hardware and software configuration management
- detailed cost, schedule and resource availability
- manufacturability and testability

- integration and test planning, including test anomalies and resolution

4.0 Design Assurance

4.1 Parts

The Project/Mission Team shall implement a parts program that assures mission reliability and performance requirements are met. GSFC 311-INST-001, Instructions for EEE Parts Selection, Screening, and Qualification, shall be used as a guide in selecting and processing parts.

The Project/Mission Team shall control the management, selection, application, evaluation, and acceptance of all parts through a Parts Control Board, or another similar documented parts control system. Board members shall be responsible for the review and approval of all parts for conformance to the GSFC 311-INST-001. The Board shall define any parts screening, Destructive Physical Analysis and other tests needed to insure that mission and performance requirements will be met. The Board shall maintain an EEE Parts Identification List prior to and during the Project/Mission Team's hardware built. This list shall be updated and submitted as part of the Mission Readiness Review. The final as-built list shall be provided as part of the hardware documentation package.

The Project/Mission Team shall have access to and maintain knowledge of parts problems as reported in the Government Industry Data Exchange Program (GIDEP). Any provided NASA Alerts shall also be reviewed.

All Electrical, Electronic, and Electro-mechanical (EEE) parts shall be derated in accordance with the guidelines specified in GSFC PPL-21, Appendix B. The Project/Mission Team shall be responsible for the implementation and verification of the derating guidelines.

System design and EEE parts selection shall be such that their intended application shall be met in the predicted mission radiation environment. The resulting design shall be latch-up immune and shall minimize Single Event Upsets (SEU.)

4.2 Materials and Processes

The Project/Mission Team shall implement a Materials and Processes program. NASA Reference Publication 1124 entitled "Outgassing Data for Selecting Spacecraft Materials" shall be used as a guide for materials selection on this program. Materials that have a total mass loss (TML) <1.00% and a collected volatile condensable mass (CVCN) <0.10% shall be used on this program. If requested, the Earth Explorers Program Office may provide technical guidance in this area.

Fastener selection and use shall be controlled. GSFC S-313-100, Goddard Space Flight Center Fastener Integrity Requirements, shall be used as a guide.

Materials selected shall meet the stress corrosion cracking requirements of MSFC-SPEC-522.

Each Project/Mission Team shall maintain a list of materials (polymeric, composites and inorganic), lubricants, processes, and appropriate usage records prior to and during the hardware development. This list shall be updated and submitted as part of the Mission Readiness Review. The final as-built list shall be provided as part of the final hardware documentation package.

4.3 Reliability

The Project/Mission Team shall plan and implement a reliability program that interacts with other mission disciplines including systems engineering, hardware design, parts selection, and systems safety. This program shall be conceived and organized to effectively, efficiently, and responsively to perform tasks which enhance the expected mission lifetime. The Project/Mission Team shall develop and implement a program plan that addresses mission objectives, assigns responsibilities, and schedules tasks relative to program milestones. The reliability program, at a minimum, shall address the following objectives:

I. Design

- a) Graceful degradation is a design objective.
- a) Reduce series complexity by eliminating unnecessary parts and components.
- a) Promote failure workarounds that allow continued successful but degraded operation.
- a) By design, wherever practicable, failures shall allow continued successful, albeit degraded operation.
- a) Isolate failure impact so that effects do not propagate to other functions.
- a) Failure of non-critical functions shall not affect critical functions.
- a) Show that electrical stress applied to parts and devices meets derating requirements over the extremes of operating temperature range, voltage temperature range, and current variations.
- a) Parts meet total dose and single event effects radiation requirements.
- a) Verification that a consistent reliability process is flowed down to subcontractor(s) and suppliers.

II. Manufacture

- a) An in-process inspection program that verifies hardware is assembled as designed.
- b) A verification program that assures specified manufacturing processes are followed.

III. Test

- a) A test program that verifies finished product meets specification.
- b) A test program that verifies finished product functions as designed.

A Failure Modes and Effects Analysis (FMEA) shall be performed early in the design process to identify problem areas that do not meet these objectives and corrective action shall be recommended. The FMEA shall be updated as the design matures. GSFC Procedure No. S-302-89-01 entitled "Procedures for Performing a Failure Modes and Effects Analysis" and/or MIL-STD-1629A, "Procedures for Performing a Failure Mode, Effects and Critical Analysis" can be used as guides. The FMEA shall be available for review by the Earth Explorers Program Office. Worst case circuit analysis shall be performed for electrical and electronic component designs. Flight software timing and sizing utilizations and margins (memory, CPU throughput, and Bus I/O) shall be documented and updated periodically throughout the life of the Project/Mission.

Fault Tree Analyses (FTA) and Probability Risk Assessments (PRA) shall be performed and the results shall be made available for Earth Explorers Program Office review.

4.4 Software

The Project/Mission Team shall employ a formal, systematic program for the development of software using the guidelines of ISO 9000-3-1997. The program shall address appropriate development life cycle phases such as: requirements analysis, design, code and unit test, integration and build test, performance verification, and maintenance. Code produced shall be structured, error-free, and maintainable. Verification and Validation (V&V) and Independent Verification and Validation (IV&V) processes shall be developed and implemented for the software.

During the preliminary design process, the Project/Mission Team shall establish and document software requirements and any appropriate external interface specifications and user guides. The Project/Mission Team shall participate in a program of internal and external software reviews to validate software requirements, design, operating characteristics, and external interface requirements. Recommended software reviews shall include, as a minimum, a Software Requirements Review, Software Preliminary (Architectural) Design Review, Software Critical (Detailed) Design Review, Software Test Readiness Review, Software Acceptance Review.

The Project/Mission Team shall employ a software configuration management process to manage requirements, code, documentation, and data, and to track and report on the status of changes to them. The process shall include a software problem reporting and corrective action system to track and disposition identified discrepancies in the product.

5.0 Verification

Each Project/Mission Team shall conduct a verification program to ensure that the flight hardware meets the specified mission requirements. The program shall consist of functional demonstrations, analytical investigations, physical measurements and tests that simulate all expected environments. Each Project/Mission Team shall provide adequate verification documentation including a verification plan and matrix, environmental test matrix, and verification procedures.

Guidelines for developing a verification program are contained in the GSFC General Environmental Verification Specification for STS and ELV Payloads, Subsystems and Components (GEVS), which is available on the World Wide Web at the following URL: <http://arioch.gsfc.nasa.gov/302/verifhp.htm>.

6.0 Contamination

The Project/Mission Team shall identify contamination requirements, and establish and maintain a contamination control program consistent with mission requirements.

7.0 Independent Mission Operations Requirements

Missions being operated by a Principal Investigator (PI) independent of NASA must meet the following additional requirements. After on-orbit checkout, incident reports must be provided to the GSFC Earth Science Mission Operations (ESMO) Project in accordance with “GSFC Flight Program Incident Reporting System Guidelines”. Weekly on-orbit status summary reports shall be provided to ESMO. It is the PI institution’s responsibility to contractually ensure the availability of spacecraft developer support of anomaly resolution efforts during the mission’s operational phase. Structured management approaches to risk management and orbital mission configuration control must be in place during the operational phase. An annual mission risk assessment status report shall be provided to ESMO.

8.0 Red Team Reviews

Red Team Reviews shall be implemented as part of the review process beginning at CDR. These reviews will enhance the probability of mission success by bringing to bear additional technical expertise to review all mission critical aspects of each program.

The mission elements to be fully addressed and evaluated during the review process shall be as follows:

- Spacecraft/Instruments/Initial operations safety
- Payload to launch vehicle integration
- Launch vehicle mission unique changes
- Unique-to-mission operations

SOMO/Institutional mission operations shall be addressed on a mission unique requirements basis only. Mission science operations shall be limited to systems needed for data capture, processing, archiving and distribution only.

The reviews shall consist of a critical technical implementation and operations review on each individual mission from the perspective of looking at what could go wrong and cause the mission to be less than fully successful. Specific key processes used by the project in the implementation of the mission shall be reviewed. The results of some of these key processes shall be reviewed and assessed as well. From this information the Review Team shall identify and document all remaining risk that could prevent complete mission success. Each Project shall be required to assemble all pertinent information (using specific formats) and present that information to the Review Team.

Addressing all of the in-scope mission elements as specified above, the Project shall assemble and present data in specified formats, that addresses (or provides) the following:

1. The level, competence and independence of technical peer reviews that were performed on each of the elements and components.
1. The performance, level and independence of system level reviews that were conducted.

1. The level and thoroughness to which the test and verification program was implemented. The test and verification program at all levels from black box to spacecraft and integrated mission shall be detailed. This shall also include the V&V and IV&V processes used on software.
1. The level of mission assurance that was imposed on the implementation of the mission. This shall include parts usage as well as workmanship standards imposed. It shall also address the software assurance processes implemented.
1. The systems management imposed and implemented the mission. This shall include the performance and thoroughness of analyses, requirement management, systems engineering, software metrics, configuration management, documentation and technical record-keeping and workmanship and test process management.
1. Factors such as staffing and the experience of the implementing organization.
1. The results of the test and integration process of all of the hardware and software elements of the mission. This shall include information on the review and assessment of all failures and anomalies and their resolution.
1. Information on the failure-free as well as the total operating time on all mission critical hardware and software.
1. The results of the technical review process shall be detailed. It shall include an assessment of all RFAs and the Project responses to those RFAs.
1. The amount, level and fidelity of mission simulations and launch/operations training that was done or is planned to be done to prepare the mission for launch and on orbit operations including identification of all planned contingency operations and of those operations which were or will be practiced by the operations team. Identify any green card exercises (postulated mission contingencies which require action by the operations team) planned or conducted with the operations team. Provide a spacecraft mission timeline from liftoff to commencement of normal science operations and identify for each step the corrective action to be taken if the mission event does not occur as planned.
1. Provide the Failure Mode and Effects Analyses (FMEA) and the Fault Tree Analyses (FTA) that were performed for the program with appropriate annotations and tutorials. Provide the results of the Probability Risk Assessments (PRA) and Worst Case Circuit Analyses (WCCAs) that were performed.
1. Provide a mission requirements Verification Matrix that shows the pre launch verification of the mission level requirements. This matrix shall address both the fidelity and type of verification.
1. Identify all single point failures and provide a subjective assessment of the probability of each such failure mode causing a mission failure. Also provide adequate rationale to substantiate the subjective assessment.

In reviewing the above items, the Review Team shall focus on implementations that could contain unevaluated risk to mission success.

9.0 Continuous Risk Management

All Project/Mission Teams shall implement a Continuous Risk Management System (CRMS) that provides for the identification; analysis; tracking; communication; resolution; mitigation; and retirement of Project/Mission Risks. The CRMS shall include the development;

maintenance; and presentation of a Mission Top Ten Risk List. This list will include a description of the risk, along with a mitigation/elimination strategy and status. The CRMS shall be implemented in accordance with the guidelines set forth in the Earth Explorers Risk Management Plan (470-PLAN-007).

APPENDIX I

GENERAL INSTRUCTIONS AND PROVISIONS

[Per NFS 1872.705-1]

I. Instrumentation and/or Ground Equipment

By submitting a proposal, the investigator and institution agree that NASA has the option to accept all or part of the offeror's plan to provide the instrumentation or ground support equipment required for the investigation or NASA may furnish or obtain such instrumentation or equipment from any other source as determined by the selecting official. In addition, NASA reserves the right to require use, by the selected investigator, of Government instrumentation or property that becomes available, with or without modification, that meets the investigative objectives.

II. Tentative Selections, Phased Development, Partial Selections, and Participation with Others

By submitting a proposal, the investigator and organization agree that NASA has the option to make a tentative selection pending a successful feasibility or definition effort. NASA has the option to contract in phases for a proposed experiment, and to discontinue the investigative effort at the completion of any phase. The investigator should also understand that NASA may desire to select only a portion of the proposed investigation and/or that NASA may desire the individual's participation with other investigators in a joint investigation, in which case, the investigator will be given the opportunity to accept or decline such partial acceptance or participation with other investigators prior to a NASA selection. Where participation with other investigators as a team is agreed to, one of the team members will normally be designated as its team leader or contact point.

III. Selection Without Discussion

The Government reserves the right to reject any or all proposals received in response to this AO when such action shall be considered in the best interest of the Government. Notice is also given of the possibility that any selection may be made without discussion (other than discussions conducted for the purpose of minor clarification). It is therefore emphasized that all proposals should be submitted initially on the most favorable terms that the offeror can submit.

IV. Foreign Proposals

See AO Section 3.3.

V. Treatment of Proposal Data

It is NASA policy to use information contained in proposals and quotations for evaluation purposes only. While this policy does not require that the proposal or quotation bear a restrictive notice, offerors or quoters should place the following notice on the title page of the proposal or quotation and specify the information subject to the notice by inserting appropriate identification, such as page numbers, in the notice. Information (data) contained in proposals and quotations will be protected to the extent permitted by law, but NASA assumes no liability for use and disclosure of information not made subject to the notice. To prevent inadvertent disclosure, proposal data shall not be included in submissions (e.g., final reports) that are routinely released to the public.

RESTRICTION ON USE AND DISCLOSURE OF PROPOSAL AND QUOTATION INFORMATION (DATA)

The information (data) contained in [insert page numbers or other identification] of this proposal or quotation constitutes a trade secret and/or information that is commercial or financial and confidential or privileged. It is furnished to the Government in confidence with the understanding that it will not, without permission of the offeror, be used or disclosed for other than evaluation purposes; provided, however, that in the event a contract is awarded on the basis of this proposal or quotation the Government shall have the right to use and disclose this information (data) to the extent provided in the contract. This restriction does not limit the Government's right to use or disclose this information (data) if obtained from another source without restriction.

VI. Status of Cost Proposals (U.S. Proposals Only)

The investigator's institution agrees that the cost proposal is for proposal evaluation and selection purposes, and that following selection and during negotiations leading to a definitive contract, the institution may be required to resubmit cost information in accordance with FAR 15.403-5.

VII. Late Proposals

Proposals or proposal modifications received after the latest date specified for receipt may be considered if a significant reduction in cost to the Government is probable or if there are significant technical advantages, as compared with proposal previously received.

VIII. Source of Space Transportation System Investigations

Investigators are advised that candidate investigations for Space Transportation System (STS) missions can come from many sources.

IX. Disclosure of Proposals Outside Government

NASA may find it necessary to obtain proposal evaluation assistance outside the Government. Where NASA determines it is necessary to disclose a proposal outside the Government for evaluation purposes, arrangements will be made with the evaluator for appropriate handling of the proposal information. Therefore, by submitting a proposal, the investigator agrees that NASA may have the proposal evaluated outside the Government. If the investigator or institution desires to preclude NASA from using an outside evaluation, the investigator or institution should so indicate on the cover. However, notice is given that if NASA is precluded from using outside evaluation, it may be unable to consider the proposal.

X. Equal Opportunity (U.S. Proposals Only)

By submitting a proposal, the investigator and institution agree to accept the following clause in any resulting contract:

EQUAL OPPORTUNITY

During the performance of this contract, the Contractor agrees as follows:

- (a) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.
- (b) The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, or national origin. This shall include, but not be limited to, (1) employment, (2) upgrading, (3) demotion, (4) transfer, (5) recruitment or recruitment advertising, (6) layoff or termination, (7) rates of pay or other forms of compensation, and (8) selection for training, including apprenticeship.
- (c) The Contractor shall post in conspicuous places available to employees and applicants for employment the notices to be provided by the Contracting Officer that explains this clause.
- (d) The Contractor shall, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.
- (e) The contractor shall send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding the notice to be provided by the Contracting Officer, advising the labor union or workers' representative of the Contractor's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.
- (f) The Contractor shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

- (g) The Contractor shall furnish to the contracting agency all information required by Executive Order 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor. Standard Form 100 (EEO-1), or any successor form, is the prescribed form to be filed within 30 days following the award, unless filed within 12 months preceding the date of award.
- (h) The Contractor shall permit access to its books, records, and accounts by the contracting agency or the Office of Federal Contract Compliance Programs (OFCCP) for the purposes of investigation to ascertain the Contractor's compliance with the applicable rules, regulations, and orders.
- (i) If the OFCCP determines that the Contractor is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, the contract may be canceled, terminated, or suspended in whole or in part, and the Contractor may be declared ineligible for further Government contracts, under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against the Contractor as provided in Executive Order 11246, as amended, the rules, regulations, and orders of the Secretary of Labor, or as otherwise provided by law.
- (j) The Contractor shall include the terms and conditions of subparagraph 1 through 9 of this clause in every subcontract or purchase order that is not exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subcontractor or vendor.
- (k) The Contractor shall take such action with respect to any subcontract or purchase order as the contracting agency may direct as means of enforcing these terms and conditions, including sanctions for non-compliance; provided, that if the Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of direction, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

XI. Patent Rights

- (a) For any contract resulting from this solicitation awarded to other than a small business firm or nonprofit organization, the clause at NFS 1852.227-70, "New Technology", shall apply (suitably modified to identify the parties). Such contractors may, in advance of contract, request waiver of rights as set forth in the provision at NFS 1852.227-71, "Requests for Waiver of Rights to Inventions".
- (b) For any contract resulting from this solicitation awarded to a small business firm or nonprofit organization, the clause at FAR 52.227-11, "Patent Rights--Retention by the Contractor (Short Form)" (as modified by NFS 1852.227-11) shall apply (suitably modified to identify the parties).

[Per NFS 1852.227-14]

XII. Data Rights

For any NASA contract resulting from this solicitation, the clause at FAR 52.227-14, “Rights in Data – General” (as modified by NFS 1852.227-14) shall apply (suitably modified to identify the parties).

[Per FAR 52.219-8 and NFS 1852.219-76]

XIII. Participation Of Small, Small Disadvantaged, And Women-Owned Small Businesses, And Minority Institutions

Offerors are advised that, in keeping with Congressionally mandated goals, NASA seeks to place a fair portion of its contract dollars, where feasible, with small business concerns, veteran-owned small business concerns, service-disabled veteran-owned small business concerns, HUB Zone small business concerns, small disadvantaged business concerns, and women-owned small business concerns, Historically Black Colleges and Universities (HBCUs), and other minority educational institutions (OMIs), as these entities are defined in 52.219-8 and 52.226-2 of the FAR. Offerors will be evaluated on the participation in the performance of the mission of small disadvantaged business concerns in the authorized North American Standard Industrial Classification (SIC) Groups as determined by the Department of Commerce (see FAR 19.201(b)), as well as the participation of women-owned small business concerns, HBCUs and OMIs.

NASA contracts resulting from this solicitation which offer subcontracting possibilities, exceed \$500,000, and are with entities other than small business concerns, will contain the clause at FAR 52.219-9. Offerors who are selected under the Step-Two Evaluation Process under this AO, and who meet the foregoing conditions, will be required to negotiate appropriate subcontracting plans. Failure to submit and negotiate a subcontracting plan shall make the offeror ineligible for an award.

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APPENDIX J

FLIGHT AND GROUND SAFETY REQUIREMENTS

Note: This Appendix to the ESSP AO describes the general Flight and Ground Safety Requirements for Earth Explorers at the NASA Goddard Space Flight Center, and is representative of the requirements at other NASA Centers. In accordance with NASA's plan to transfer program management responsibility to the Field Centers and designate Lead Centers for multi-center programs, Goddard Space Flight Center is assigned the Lead Center responsibility for Earth Explorers Projects, including the Earth Systems Science Pathfinder (ESSP). As Lead Center, Goddard will be responsible for establishing and tracking program metrics and for reporting program status and progress to NASA Headquarters.

PREFACE

The purpose of this document is to serve as a resource to the Project/Mission Team of each Earth Explorers project/mission for complying with necessary NASA safety requirements.

1.0 Overview

1.1 PURPOSE

All Mission/Project Teams shall establish, implement and maintain a system safety program in accordance with the following requirements:

- Identifies and controls hazards to personnel, facilities, support equipment, and the flight system during all stages of mission/project development. The safety program shall address hazards in the flight hardware, associated software, ground support equipment, and support facilities.
- Meets the system safety requirements stated in the applicable launch site safety regulation.
- Meets the baseline industrial safety requirements of each mission/project team member's institution, as well as any special contractually imposed mission/project unique obligations.

The safety program shall be documented in a Safety Plan for each Mission/Project, and shall apply to all work performed by the Mission/Project, its subcontractors and suppliers, and Mission Team members.

2.0 Flight Systems

2.1 FLIGHT SYSTEMS (Hardware & Software)

Flight hardware and software systems developers shall implement a system safety program in accordance with the requirements imposed by the appropriate launch range and the launch vehicle manufacturer or launch service provider. The requirements are mandatory and are not negotiable, but may be tailored to the extent that not all requirements apply to every project/mission. The tailoring of the requirements to the specific mission is done with the applicable launch range safety organization.

Each project/mission shall comply with the “NASA Policy for Limiting Debris Generation” (NPD 8710.3) and the NASA Safety Standard “Guidelines and Assessment Procedure for Limiting Orbital Debris” (NSS 1740.14). Each Project/Mission Team shall be responsible for performance of the required orbital debris assessment.

The following are mandatory compliance requirements for hardware and software intended to be launched on any of the various launch vehicles/launch services. The Mission/Project Team ensures compliance with the requirements and certifies to the launch range, in the form of the Safety Data Package, that all of the requirements have been met.

The following documents describe the complete safety program implementation and deliverables required to safely launch space hardware. The documents reference other requirements that the flight system developer must also meet to gain access to the launch site and subsequent launch.

3.0 Documentation

3.1 TOP LEVEL SAFETY REQUIREMENTS DOCUMENTS

Any payload (ELV or Shuttle) using Kennedy Space Center (KSC) facilities for testing, integration, etc. (including those at Eastern Test Range (ETR) and Western Test Range (WTR) where KSC has jurisdiction for reviewing procedures and facilities) shall comply with KHB 1710.2C, “Kennedy Space Center Safety Practices Handbook.”

For Shuttle Missions:

- 1) NSTS 1700.7B, “Safety Policy and Requirements for Payloads Using the Space Transportation System.”
- 2) 45 SPW S-100/KHB 1700.7B, “Space Shuttle Payload Ground Safety Handbook.”

For ELV Missions at ETR or WTR:

EWB 127-1, “Eastern and Western Range Safety Requirements.”

For Wallops Flight Facility (WFF) Missions:

RSM-93, “Range Safety Manual for Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF).”

For Missions flying on the Pegasus launch vehicle:

- 1) “Pegasus Design Safety Requirements Document” (SSD TD-0005) (currently Rev B).
- 2) “Pegasus Safety Requirements Document for Ground Operations” (SSD TD-0018) (currently Rev A).

APPENDIX K

PROPOSAL FORMAT AND CONTENT

The following guidelines apply to the preparation of proposals in response to this ESSP AO. The material presented is a guide for the prospective proposer, and is not intended to be all encompassing. The proposer shall, however, provide information that is relative to those items applicable, as well as other items required by the AO. In the event of an apparent conflict between the guidelines in this Appendix and those contained within the body of the AO, those within the AO shall take precedence. Note that this appendix provides format (Tables K-1 and K-2) and content guidelines that apply to both Step-One and Step-Two proposals. Table K-1 specifies the page limits for each step in the proposal process. Remember that the Step-One evaluation is intended to assess the in-depth scientific/applications merits, justification and maturity of the proposed investigation in relation to the ESSP research objectives and scientific questions. However, all of the sections shall be covered but in varying degrees of detail as indicated by the page limits in Table K-1. Guidelines for the Mission Confirmation Review can be found in Appendix D. The Compliance Table (see Table K-3) is intended to help the proposer ensure that all requirements in the AO have been addressed in the proposal. The table may not cover every required element and it is the proposers responsibility to include all required elements in the proposal. If NASA selects a Step-One proposal the PI will be requested to submit a Step-Two proposal. Failure to follow all proposal formats; content and other instructions may result in reduced ratings during the evaluation process and could lead to rejection of the proposal.

FORMAT GUIDELINES

All documents shall be single-spaced typewritten in English (without reduction), use the International System (SI) of units, and be clearly legible. All cost estimates, including foreign contributions, shall be in real year U.S. Dollars. Submission of proposal material by facsimile (fax), electronic media, videotape, floppy disk (except as noted below), etc., is not acceptable. In evaluating proposals, NASA will only consider printed material. Although you are allowed to provide references to published papers, World Wide Web sites, etc., your proposal cannot rely upon these. The Evaluation panels are not obligated to check or refer to these references.

All proposers shall provide 35 copies of their paper proposal, including the original signed proposal, on or before the proposal deadline. The proposals shall be numbered sequentially from 1 to 35 in the upper right-hand corner of the cover page; the original signed proposal shall be number 1. These requirements apply to both Step-One and Step-Two proposals.

The Step-One proposal **shall** consist of one volume; however, the Step-Two proposal **shall** consist of two volumes, with readily identified sections corresponding to the sections identified in Table K-1. **Note** the requirements on page count for the various sections of Step-One and Step-Two proposals specified in Table K-1. Step-One proposals (originals and copies) shall be bound. Step-Two proposals (originals and copies) shall be provided in 3-ring loose-leaf binders.

In order to allow for recycling of proposals after the review process, all proposals and copies shall be submitted on plain white paper only (e.g., no cardboard stock or plastic covers, no colored paper, etc.). Photographs and color figures are permitted if printed on recyclable white paper only. The original signed copy shall be bound in a manner that makes it easy to disassemble for reproduction. Except for the original, two-sided copies are preferred. Every side upon which printing appears will be counted against the page limits. Each foldout page count as one or two pages depending upon the number of sides upon which printing appears.

Table K-1. Proposal Page Count Limits

Volume	Section	Section Name	Page Limits	
			Step-One	Step-Two
I	A	Cover Page	1 page (not part of proposal limit)	
	B	Investigation Summary	Use ESSP Forms I & II <u>only</u> (not part of proposal limit)	
	C	Fact Sheet	1 page (front & back; not part of proposal limit)	
	D	Table of Contents	No limit (not part of proposal limit)	
	E	Endorsement Summary	1 page (not part of proposal limit)	
	F	Science/Applications Investigation	12 pages	25 pages
	G	Technical	5 pages	50 pages
	H	Management	3 pages	25 pages
	I	Cost and Cost Estimating Methodology Summary	3 pages	3 pages
	J	Education	0 pages	10 pages
	K	Other Opportunities	0 pages	5 pages
	L	Appendices:	No page limit, but small size encouraged	No page limit, but small size encouraged
II	A	Cover page (copy of section A)	0 pages (not required for Step-One Proposals)	1 page (not part of proposal limit)
	M	Cost Methodology and cost Estimating Details	0 pages	No limit

Table K-2 gives specifics of the required proposal page format. Figure captions shall be in 12 point. A smaller font is allowed within figures, Investigation Summary Forms, and in the cost tables, but no less than 8 point.

Table K-2. Format and Layout.

Page Size	8.5X11 inches or A4 European standard
Page Layout	Single or Double-Column
Margins	1 inch top and bottom 1 inch left and right sides
Lines per page	55 lines max
Foldout pages	Step-One: none Step-Two: Maximum 4 pages; 11 x 17 inches Step-Two Cost, Section M: unlimited
Font size	No smaller than 12-point Times (approx. 15 characters per inch)
Proposal Binding	Step-One: Bound Step-Two: 3-Ring loose leaf notebook

As described in Sections 4.2.3 of this Announcement, the proposer shall provide electronic versions of the proposal, along with a brief description of the contents of the electronic media. All information shall be provided on DOS-compatible (version 5.0 or higher) 100 Megabyte Zip disks or CD ROM and in pdf and Microsoft Word for Windows format (version 6.0 or later) or Microsoft Excel Version (windows 95 or later). It is suggested that spreadsheets **not** be “paste values”, but be left in the form wherein formulas may be viewed. If the cost review panel does not understand a cost element on the printed page, they may be able to use the spreadsheet formulas to understand the item.

Do not include information on the electronic media that is not included in the paper volumes of the proposal. If the electronic media are found to include information that differs from the paper volume or are found to be defective (e.g., non-readable) the electronic media will be returned to the proposer and the proposer shall promptly provide replacement media. These replacement media will not be considered a late proposal under NFS 1872.705-1 VII. Electronic media **shall** be checked for computer viruses before submission.

If you find it necessary to segment the proposal on multiple electronic media either because of space or other limitations, the files should be as large as possible and have a logical relationship to the proposal structure. Also provide a brief description explaining the file structure, naming conventions, and other information that the proposer feels may be helpful to use these files. Include the name of the proposal, name of the PI with telephone number, name and version of the software used to check the disks for computer viruses. The PI shall sign this page certifying the electronic media is virus free. These pages do not count toward the proposal pages limit.

PROPOSAL CONTENT GUIDELINES

The Step-One and Step-Two proposal outline and content are described below. See Table K-1 for page limits for each Step and Section in the proposal process. Format and layout information for the proposal is given in Table K-2. Only the high level table of contents given in Table K-1

is required (i.e., Sections A through L). The lower level subsection headings are advisory. Proposers shall also refer to the evaluation criteria listed in Section 5 of the AO to ensure that the proposal addresses the factors NASA will use to evaluate the proposal.

An AO requirements Compliance Table is provided in Table K-3. It is intended to help ensure that all requirements have been included in a proposal. However, the table may not include every requirement and it is the responsibility of the proposer to ensure that all requirements have been included in the proposal.

Table K-3. Compliance Table

Item	Section	Table	Requirement	Required for		Included
				Step-One	Step-Two	
1	A		Cover Page	✓	✓	
2	B		Investigation Summary (Forms I and II)	✓	✓	
3	C		Fact Sheet	✓	✓	
4	D		Table of Contents	✓	✓	
5	E		Endorsement Summary	✓	✓	
6	F		Science/Applications Investigation	✓	✓	
7	F		Baseline and Minimum Science/Applications Missions	✓	✓	
8	F		Sensitivity Analysis	✓	✓	
9	F	L-2a	Instrumentation Technical Maturity Matrix	✓	✓	
10	F	L-3	Science Traceability Matrix	✓	✓	
11	F	K-4	Instrument Information Table	✓	✓	
12	G		Technical Implementation	✓	✓	
13	G	K-7	Launch Services Table	✓	✓	
14	G		Data Systems		✓	
15	G	L-4	Mission Traceability Matrix	✓	✓	
16	G	K-5a b	Mission Design Table	✓	✓	
17	G	L-2b	Spacecraft Technical Maturity Matrix		✓	
18	G	K-6	Spacecraft Characteristics Table		✓	
19	G		Manufacturing, Integration and Test Strategy		✓	
20	G	K-8	Mission Operations, Ground and Data Systems Table		✓	
21	G		Plans to Resolve Open Technical Implementation Issues		✓	
22	H		Management Processes and Plans	✓	✓	
23	H		Work Breakdown Structure	✓	✓	
24	H		Principal Investigator	✓	✓	
25	H		Project Manager		✓	
26	H		Co-Investigators		✓	
27	H		Mission Schedule	✓	✓	
28	H		Mission Reviews		✓	
29	H		Risk Management Plan		✓	

Table K-3. Continued

Item	Section	Table	Requirement	Required for		Included
				Step-One	Step-Two	
30	H		Mission Assurance and Safety		✓	
31	H	L-5	Mission Assurance Compatibility Table		✓	
32	H		Facilities and Equipment		✓	
33	H		Plans to Resolve Open Management Issues		✓	
34	L		Preliminary Mission Definition and Requirements Agreement Appendix		✓	
35	L		Draft Incentive Plan Appendix		✓	
36	L		Relevant Experience and Past Performance Appendix		✓	
37	L		Draft International Agreements Appendix		✓	
38	L		Contractual Requirements Appendix		✓	
39	I	K-9	Cost and Cost Estimating Methodology Summary	✓	✓	
40	I		NASA Mission Cost in Real Year Dollars		✓	
41	I		Contributions		✓	
42	I		Total Mission Life Cycle Cost Phasing in Real Year Dollars		✓	
43	I		Plans to Resolve Open Cost Issues		✓	
44	J		Education		✓	
45	K		Small, Small Disadvantaged, and Women/Veteran-owned Small Businesses and Minority Institutions		✓	
46	K		Commercialization		✓	
47	K		Plans to Resolve Open Other Opportunity Issues		✓	
48	L		Resumes	✓	✓	
49	L		Letters of Endorsement		✓	
50	L		Civil Rights Certification		✓	
51	L		Certification Regarding Lobbying			
52	L		Verification Regarding Debarment, Suspension, and Other Responsibility Matters Primary covered Transactions		✓	
53	L		Statement of Work		✓	
54	L		Acronyms List	Optional	Optional	
55	L		Reference List	Optional	Optional	
56	M	L-6, 7, 8, 9	Cost and cost Estimating Details		✓	
57	M		Summary of Elements of Cost		✓	
58			Electronic Version of Proposal	✓	✓	
59	M		Site Visit Location		✓	

A. COVER PAGE

A cover page shall be a part of the proposal, but will not be counted against the page limit. The Principal Investigator and an official by title of the investigator's organization that is authorized to commit the organization shall sign the cover page. The full names of the Principal Investigator and the authorizing official, their addresses with zip code, telephone and fax numbers, and electronic mail addresses, shall be included.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Cover Page shall be included**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Cover Page shall be included**

B. INVESTIGATION SUMMARY

A summary of the proposed investigation shall be included with the proposal immediately following the cover page. ESSP Forms I and II are to be used for this Summary and are located at the end of this Appendix K. Continuation sheets are **not** allowed. The Investigation Summary is not counted against the page limit.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Investigation Summary shall be included**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Investigation Summary shall be included**

C. FACT SHEET

A one-page fact sheet is required and does not count against the proposal page count. This fact sheet should cover the most important aspects of the proposed mission. Items that shall be included are mission statement, science objective and description along with Minimum Science/Applications Mission, concept diagrams of instrument and/or spacecraft, team, schedule with major milestones and launch date, cost and reserves, and launch vehicle. NASA will use this Fact Sheet, in viewgraph form, to summarize your proposal during the evaluation.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Fact Sheet shall be included**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Fact Sheet shall be included**

D. TABLE OF CONTENTS

The proposal shall contain a table of contents, which will not be counted against the page limit. This table of contents shall parallel the outline provided in Table K-1 and below in Sections E through M.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Table of Contents shall be included**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Table of Contents shall be included**

E. ENDORSEMENTS

A maximum of one page can be used to describe the endorsements proposed. This one page summary and the letters of endorsement are not included in the maximum page count. All co-investigators, lead team members and foreign endorsements shall be included as part of the proposal. Letters of endorsement shall be provided from the following:

- Participants/Organizations in the proposal including NASA participants/organizations,
- All organizations offering goods and/or services on a no-exchange-of-NASA-funds basis,
- Foreign organizations providing hardware or software to the investigation,
- Launch Service provider, if the launch service is not provided through a NASA contract.

Letters of endorsement shall be signed by institutional and Government officials authorized to commit their organizations to participation in the proposed investigation and shall include the signature, full name, address with zip code, telephone and fax numbers, and electronic mail address. These letters shall describe the offered goods/services and their associated value/cost. The letters of endorsements shall be included in Section L of the proposal; the one page summary in Section E.

The institutions and/or governments involved shall endorse any participation by foreign individuals and/or institutions as team members or contributors to ESSP investigations. Institutional endorsement is required for contributions. If government support is required then a government endorsement is also required. The letter of endorsement shall provide evidence that the foreign institution and/or government officials are aware and supportive of the proposed investigation and will pursue funding for the investigation if selected by NASA. Such endorsements shall be submitted per the schedule in Section 1.5 and in compliance with the provisions of Sections 3.1 – 3.3, and 4.2.1. Include these letters in Section L of the proposal. An example letter of endorsement is included at the end of this Appendix K.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Description of endorsements planned at the submission of the Step-One proposal.**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Description of all endorsements**
- 2. All letters of endorsements**

F. SCIENCE/APPLICATIONS INVESTIGATION

This section shall provide a detailed discussion of the planned scientific investigation to be conducted. This includes identifying the science question(s) to be addressed; the measurement approach and objectives; the underlying physics of the proposed measurements; scientific problem relevance to the Earth Science Enterprise and complementarity to EOS and other ESE approved flight programs; science measurement requirements (lifetime, orbit, resolution, accuracy, etc.); Baseline Science Mission and Minimum Science Mission; science team members and their experience and area of expertise relative to the science measurement objectives; science validation and correlative measurement plan; algorithm development plan; and data processing and distribution plan. The scientific/applications objectives and methodologies shall be consistent during the Step-One and Step-Two proposal processes.

1. Science/Applications Goals, Objectives, and Justification

Establishing research priorities becomes a major challenge when priorities cross a number of different disciplines, each embracing a large set of scientific questions. The challenge facing the ESE is to balance competing demands in the face of limited resources and chart a program that addresses the most important and tractable scientific questions and allows optimal use of NASA's unique capabilities for global observation, data acquisition and analysis, and basic research. To this end, choices need to be made between many projects, all of which are important, timely, and ready to succeed. Most significant from a strategic perspective are the choices between different but equally promising candidate space flight missions or measurement systems.

Thus, NASA's selection of priorities involves both scientific needs and implementation realities. Scientific considerations are paramount and start the prioritization process. These considerations determine what science questions, and ultimately which missions and research projects shall be pursued. Purely scientific considerations are followed by considerations of science-related context (e.g., benefit to society, mandated programs), followed in turn by implementation considerations. The latter, such as technology readiness, tend to influence the order in which science projects are pursued and the final shape they may take. These practical considerations often result in some feedback and iteration of project selection.

The key research topics studied by NASA's Earth Science Enterprise fall largely into three categories: forcings, responses, and the processes that link the two and provide

feedback mechanisms. This conceptual approach applies to all research areas of NASA's Earth Science program. The scientific strategy to address this complex problem can be laid out in five fundamental questions, each raising a wide range of cross-disciplinary science problems.

- *How is the global Earth system changing?*
- *What are the primary forcings of the Earth system?*
- *How does the Earth system respond to natural and human-induced changes?*
- *What are the consequences of change in the Earth system for human civilization?*
- *How well can we predict the changes to the Earth system that will take place in the future?*

While these five questions define a logical progression in the study of global change, each one covers a range of topics too broad to serve as a simple guide for program implementation. For this purpose, more specific research questions need to be formulated and prioritized. The ESSP Project is designed to both complement and extend the existing ESE flight program strategy. This third ESSP AO seeks to address the following Earth science research priorities and associated questions based on a logical progression of our current understanding (as listed in Section 2.2 of the ESSP AO).

Earth System Variability and Trends

- How are global precipitation, evaporation, and the cycling of water changing?

Primary Forcings of the Earth System

- What trends in atmospheric constituents and solar radiation are driving global climate?
- How is the Earth surface being transformed, and how can this information be used to predict future changes?

Earth System Responses and Feedback Processes

- What are the effects of clouds and surface hydrologic processes on climate change?
- How do ecosystems respond to and affect global environmental change and the carbon cycle?
- How can climate variations induce changes in the global ocean circulation?
- How do stratospheric trace constituents respond to change in climate and chemical composition?
- How is global sea level affected by climate change?
- What are the effects of regional pollution on the global atmosphere, and the effects of global chemical and climate changes on regional air quality?

NASA will consider scientifically compelling proposals based on other scientific questions, but proposers shall provide a clear and concise justification in the Step 1 proposal.

An explicit scientific justification of the proposed investigation shall be provided. This includes:

- defining the role of the proposed investigation in addressing key Earth science research objectives and scientific question(s) outlined in Section 2.0 of the ESSP AO,
- its applicability to current environmental issues,
- how it differs from or complements existing or approved spaceflight missions,
- documentation of the existing state of knowledge with respect to the problem to be addressed including existing models and observations,
- articulation of how the proposed mission addresses the stated problem, research objectives, or scientific questions in terms of measurement characteristics and instrumentation including the requisite in situ/correlative measurements necessary to provide an integrated observation strategy, and
- a definition of the mission characteristics, including specifics of the spatial and temporal sampling modes and precision and accuracy. In addition, a detailed sensitivity analysis shall be provided that illustrates the anticipated improvements in the state of knowledge/understanding as a result of reductions in uncertainty and describes how the proposed measurement set extends the state of Earth System Science knowledge in the problem area defined with respect to existing physical models, observational data set(s), and/or observational trends. All references cited should be available from literature (i.e., commonly available journals and books) or easily accessible as preprints (i.e., accepted for publication). The impact of degradation of mission characteristics on the scientific objectives of the investigation shall also be described.

Plans and/or technology insertion roadmaps for transferring technologies to other missions, and/or to the private sector, including the non-aerospace sector are encouraged. The means by which NASA's Office of Earth Science plans to implement new technology is described in the *Office of Earth Science Integrated Technology Strategy* (<http://www.earth.nasa.gov/visions/index.html>) and the *NASA Technology Plan* (<http://technologyplan.nasa.gov/>).

2. Measurement Objectives and the Nature of the Investigation

Proposals shall cover the end-to-end investigation to answer the over-arching Earth system scientific/applications questions. The relationship between the proposed scientific objectives, the data to be returned, and the instrument payload to be used in carrying out the proposed investigation shall be unambiguous and clearly stated in the proposal. Any support activities including balloon, aircraft, and ground validation/calibration activities shall be described.

The proposal shall demonstrate that the proposed mission would acquire the necessary results within the life span of the mission. The mission shall not require an extension of the mission beyond the life proposed and costed in the proposal. Extended missions will not be considered as part of this AO.

Include also a discussion of any descope or reduced mission performance options. Discuss the impacts of these and the scientific/application resilience of the investigation.

3. Instrumentation

This section shall fully describe the proposed science instrumentation to be provided, including the criteria for its selection. The linkage between the required physical measurements and the proposed instrumentation shall be described in detail. In addition, an assessment of the technical maturity of all proposed instrumentation shall be provided. This Instrumentation Technical Maturity Matrix shall include the name of each major element, a description of the item, an assessment of its maturity level (according to the definitions in Appendix L, Figure L-1) and rationale for each maturity assessment given, including examples of heritage, existing instruments, breadboards, and prototypes, if any. The format of the Instrumentation Technical Maturity Matrix shall be as shown in Appendix L, Figure L-2 (a).

To quantitatively document how the proposed instrumentation permits key scientific problems to be addressed, a traceability analysis is required. The details of the mapping between scientific objectives and the measurements required to fulfill these objectives shall be provided, as well as the mapping between functional requirements and top-level engineering requirements. This analysis shall be presented as the Science Traceability Matrix, with individual scientific requirements mapping into functional requirements, which themselves map into higher order engineering requirements. The matrix format shown in Appendix L, Figure L-3 shall be used.

A description of the operational scenario/modes and an overall functional description and block diagram for all instrumentation shall be provided. Instrumentation concept, feasibility or definition studies already performed shall be summarized. Instrumentation performance requirements (resolution, sensitivity, and accuracy) shall be related to the proposed science measurement objectives for both the Baseline and Minimum Science Missions described above. A description of the technology/development risks and the plan to address them shall be included. A schedule for instrument development shall be provided. In addition, provide the instrument information requested in Table K-4 (can be preliminary for Step-One):

4. Anticipated Science/Applications Return

The relationship between the data products generated and the scientific/applications objectives shall be explicitly described, as shall the expected results. ESSP mission teams will be responsible for the measurements to be taken in the course of the mission, the data to be returned, the approach that will be taken in analyzing the data to achieve the scientific objectives of the investigation, the initial analysis of the data, its subsequent delivery to an appropriate data repository, the publication of scientific findings, and communication of results to the science community and public. The proposal shall provide a discussion of the scientific/applications products and how the science/applications products and data obtained will be used to fulfill the scientific objectives. This shall include a discussion of how the science/applications data will be obtained, including a plan for delivery of the products, and the individuals responsible for

the data delivery. This description shall identify the investigation to be performed, the quality of the data to be returned (resolution, coverage, pointing accuracy, measurement precision, etc.), and the quantity of data to be returned (bits, images, etc.).

Table K-4. Instrument Information.

Item	Value/Summary	Units
Sensor type		N/A
Number of channels		N/A
Size, meters x meters x meters		
Mass with contingency*, kg and %		
Power with contingency (nominal, peak, duty cycle, standby), watts and %		
Data rate with contingency, kbps and %		
Mechanical, electrical, and thermal layouts		N/A
Optical layout including field of view (if appropriate)		N/A
Ground and on-orbit calibration scheme		N/A
Pointing requirements (knowledge, control, and stability), degrees		
Command and control requirements		N/A
Flight software architecture (use of existing or commercial off the shelf or hybrid software shall be identified)		
Definition of instrument operational modes over all science phases with power and data requirements, watts and kbps		

*Contingencies and margins are defined in Appendix L.

Note: Where applicable, please provide a full description of the values/summaries in the text of the proposal.

The plan for algorithm development shall be discussed. In addition, the data reduction and analysis plan, after the data have been delivered to the ground, shall be discussed, including the method and format of the data reduction, data calibration and validation, and preliminary analysis. The process by which data will be prepared for archiving and distribution shall be discussed, including a list of the specific data products and the individual team members responsible for the data products. The plan shall include a detailed schedule for the submission of raw and reduced data to the appropriate data archive in the proper formats, media, etc. Delivery of the data to the data archive shall take place in the shortest time possible.

In accordance with NASA policy, data from NASA funded missions shall be disseminated to the scientific community without restriction for a cost of no more than the cost of dissemination. ESSP teams are encouraged to propose innovative data management processes for data dissemination and wide data distribution processes. For data from a mission with significant U.S. private sector investment, innovative data management approaches will be considered. Data are to be released as soon as possible

after a brief data validation period appropriate for the mission and the process shall be described. ESSP teams will be responsible for collecting the scientific, engineering, and ancillary information necessary to validate and calibrate the scientific data prior to depositing it in the appropriate data repository. This repository shall conform to the guidelines outlined in Appendix G. The time that is required to complete this process shall be the minimum necessary to provide appropriate data to the scientific community and the general public and shall be described in the proposal. As part of the funded data analysis, archival and dissemination activities, mission teams shall include an appropriate period for data analysis independent of archiving activities.

5. Science/Applications Team

A single Principal Investigator (PI) that will be responsible for the scientific integrity of the mission **shall** lead each ESSP mission investigation team. Co-Investigators may be from any category of U.S. or foreign organization, including educational institutions; industry or nonprofit institutions; one of the NASA Centers, the Jet Propulsion Laboratory (JPL), other Federally-funded research and development centers, or other U. S. Government agencies; or foreign organizations. However, Co-Investigators shall have an identified role in the proposal, play a defined and necessary role in the investigation, and covered in the funding plan. Teams may be formed from any combination of these institutions. This mission team has full responsibility and authority to accomplish the mission.

The capabilities and experience of all members of the proposed science team shall be described. In addition, the role of each science team member in the investigation shall be explicitly defined. Resumes or vitae of team members shall be included in an Appendix of the proposal. Any plans for producing an initial analysis of early mission data shall be described.

6. Plans to Resolve Open Science/Applications Investigation Issues

Identify and discuss any unresolved issues. Include your planned approach and schedule for resolving these issues.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Science/Applications Goals, Objectives, and Justification**
- 2. Measurement Objectives and the Nature of the Investigation**
- 3. Instrumentation, Technical Maturity Matrix (L-2a), Table K-4**
- 1. Anticipated Science/Applications Return, Science Traceability Matrix (L-3)**
- 5. Science/Applications Team**
- 6. Plans to Resolve Open Science/Applications Investigation Issues**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Science/Applications Goals, Objectives, and Justification**

- 2. Measurement Objectives and the Nature of the Investigation**
- 3. Instrumentation, Technical Maturity Matrix (L-2a), Table K-4**
- 4. Anticipated Science/Applications Return, Science Traceability Matrix (L-3)**
- 5. Science/Applications Team**
- 6. Plans to Resolve Open Science/Applications Investigation Issues**

G. TECHNICAL IMPLEMENTATION

The Technical Implementation section shall describe the method and procedures for investigation definition, design, development, integration, ground operations, and flight operations. Discuss all new technologies used for the investigation, including back-up plans with scheduled decision criteria. This section shall also detail the expected products and end items associated with each phase. Describe the capabilities and experience of all members of the proposed technical implementation team. Mission teams have the freedom to use their own processes, procedures, and methods. The use of innovative processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged when cost, schedule, and technical improvements can be demonstrated. Discuss the benefits of such processes and products.

1. Mission Design

This section shall provide an overview of the mission, including mission design, mission design drivers, instrument accommodation, spacecraft, launch vehicle and services required, orbital parameters, ground systems communications approach, and mission operations plan

Specific information shall be included that describes the unique requirements placed on these mission elements by the science/applications investigation. Proposals shall include linkage between required physical measurement and proposed mission approach. A “Mission Traceability Matrix” showing how the proposed mission design complies with the stated objectives, requirements, and constraints of the proposed investigation shall be provided. The format of the Mission Traceability Matrix shall be as shown in Appendix L, Figure L-4.

The proposal shall describe the mission observing strategy and spacecraft performance required for obtaining the necessary data with the proposed instrumentation. Include the concept for operating the mission and the requirements for mission operations. Consider providing a preliminary mission timeline indicating periods of data acquisition, data downlink, eclipses, etc. Include the rationale for the selection of the launch option.

The heritage and maturity of mission elements including, the spacecraft, ground systems, and mission design shall be addressed. The proposal shall describe the systems engineering approach including the integration and test approach, trade studies to be conducted, and the approach to flight assurance, including reliability and redundancy. The rationale for the selection of launch vehicle shall be provided. If not NASA-provided, the prior demonstrated flight record and qualification history of the launch

vehicle shall be provided. In addition, the proposal shall identify and discuss any innovative features of the mission design that minimize total mission costs.

In order to assess the mission design, Table K-5 (a) data shall be provided for Step-One. Step-Two proposals shall provide the data requested in Tables K-5.

Table K-5. Mission Design Table
(a) Step-One Mission Design Table

Parameter	Value, units
Orbit Apogee Altitude, km	
Orbit Perigee Altitude, km	
Orbit Inclination, deg	
Orbit Node Time of Day for Sun Synchronous Orbits, hh:mm	
Parking Orbit Apogee Altitude, km (if applicable)	
Parking Orbit Perigee Altitude, km (if applicable)	
Parking Orbit Inclination, deg (if applicable)	
Launch Date(s), mm/dd/yy	
Mission Lifetime, days	
Communications downlinks per Day	
Communications downlink rate, mbps	
Spacecraft Dry Bus Mass, kg	
Spacecraft Propellant Mass, kg	
Launch Vehicle Margin*, kg and %	
Spacecraft Bus Power, watts	
Spacecraft Power Margin, watts and %	

*Contingencies and margins are defined in Appendix L.

(b) Step-Two Mission Design Table

Parameter	Value, units	Contingency, units
Orbit Apogee Altitude, km		N/A
Orbit Perigee Altitude, km		N/A
Orbit Inclination, deg		N/A
Orbit Node Time of Day for Sun Synchronous Orbits, hh:mm		N/A
Parking Orbit Apogee Altitude, km (if applicable)		N/A
Parking Orbit Perigee Altitude, km (if applicable)		N/A
Parking Orbit Inclination, deg (if applicable)		N/A
Launch Date(s), mm/dd/yy		N/A
Mission Lifetime, days		N/A
Maximum Eclipse Period, minutes		N/A
Spacecraft Dry Bus Mass and contingency by Subsystem, kg and %		
Spacecraft Propellant Mass and contingency, kg and %		
Launch Vehicle Margin, kg and %		N/A
Spacecraft Bus Power and contingency by Subsystem, watts and %		
Spacecraft Power Margin, watts and %		N/A

2. Instrument Implementation

This section shall describe the science/applications instrument (or instruments) for the investigation. Include a preliminary description of each instrument with a block diagram showing the instrument systems and their interfaces, along with a description of the estimated performance of the instrument. Provide a summary of the key margins, including the rationale for margin allocation. Identify those design margins that are driving costs.

The proposal shall indicate items that are to be developed, as well as any existing instrumentation or design/flight heritage. Discuss the steps needed for space qualification of your instrument. Identify any innovative features incorporated to effect cost savings. Include where appropriate calibration plans and operational/control considerations.

1. Instrument Interface and Payload Integration

This section shall characterize the interface between the science instrumentation and the spacecraft. The planned process for physically and analytically integrating the science payload with the spacecraft shall be described. Along with a description of the payload layout and configuration, the accommodation of the science instruments by the spacecraft shall be addressed as follows:

- Instrument location constraints
- Mechanical/structural interface
- Field of view, alignment and pointing
- Baffling or other protection
- Thermal environment/temperature limits
- Commands
- Timing (clocks)
- Environmental sensitivities (electrical cleanliness, magnetic fields, contamination, etc.)

The proposal shall discuss the sensitivity to or generation of contamination (e.g., electromagnetic interference, gaseous effluents, etc.), and the potential (if any) for significant instrument-generated jitter and momentum. Describe the planned process for physically and analytically integrating the instrument(s) with the flight system. Describe the testing strategy of the science/applications payload, before integration with the spacecraft.

1. Spacecraft

This section shall describe the spacecraft design approach, particularly as it relates to new versus existing hardware and redundant versus single-string hardware. It shall fully identify the spacecraft and describe its characteristics and requirements. A preliminary description of the spacecraft design with a block diagram showing the spacecraft subsystems and their interfaces shall be included, along with a description of the flight software and a summary of the estimated performance of the spacecraft. The flight heritage and/or rationale used to select the spacecraft and its subsystems, major assemblies, and interfaces shall be described. Indicate whether the planned electrical and data interfaces are standard or custom, and the rationale for the choices. In addition, an assessment of the technical maturity of each subsystem and critical component shall be provided. This “Spacecraft Technical Maturity Matrix” shall define the technology readiness level (as defined in Appendix L, Figure L-1) of each item, along with a rationale for the assigned rating. The Spacecraft Technical Maturity Matrix is separate from the previously requested Instrumentation Technical Maturity Matrix and is counted as part of the proposal page limit. The format of the Spacecraft Technical Maturity Matrix shall be as shown in Appendix L, Figure L-2(b).

Subsystem characteristics and requirements shall be described to the greatest extent possible. Such characteristics include: mass, volume, and power requirements; pointing

knowledge and accuracy; new developments needed; spaceflight qualification plan; and logistics support. Any design features incorporated to effect cost savings shall be identified. A summary of the resource elements of the spacecraft design concept, including key margins, shall be provided. The rationale for margin allocation shall also be provided. Those design margins that are driving costs shall be identified.

Plans for all phases of software development, including the use of existing (including “commercial off-the-shelf”) software, shall be described. The method planned for development and validation of flight software shall be addressed.

The method for resolving any major open spacecraft issues, major systems trades, and technology development planned in Mission Definition and Preliminary Design shall be addressed. A preliminary schedule for the spacecraft development shall be included.

In order to assess the spacecraft subsystem characteristics, the following table of data shall be provided.

Table K-6. Spacecraft Characteristics Table

Spacecraft bus	Value/ Summary, units
Propulsion	
Estimated delta-V budget, m/s	
Propulsion type(s) (monoprop, bi-prop, dual-mode, solar electric, etc.) and associated propellant(s)/oxidizer(s)	
Propellant mixture ratio (if bi-prop)	
Specific impulse of each propulsion mode, seconds	
Attitude Control	
Control method (3-axis, spinner, gravity gradient, etc.). For spin stabilized spacecraft provide spin rate and axis in terms of spacecraft body coordinate frame.	
Control reference (solar, inertial, Earth-nadir, Earth-limb, etc.)	
Attitude control capability, degrees	
Attitude knowledge limit, degrees	
Agility requirements (maneuvers, scanning, etc.)	
Articulation (1- or 2 –axis solar arrays, antennas, gimbals, etc.)	
Attitude knowledge processing (<i>e.g.</i> , real-time versus post-processing, spaceborne versus ground)	
Sensor and actuator information (precision/errors, torque, momentum storage capabilities, etc.)	
Command & Data Handling	
Spacecraft housekeeping data rate, kbps	
Data storage unit type and capacity, name and Mbits	
Maximum storage record rate, kbps	
Maximum storage playback rate, kbps	

Table K-6. Continued

Spacecraft bus	Value/Summary, units
Power	
Definition of each spacecraft subsystem operational mode over all science phases. Provide power demand in watts for each operational mode.	
Type of array structure (rigid, flexible, body mounted)	
Solar array axes of rotation (vector projected in spacecraft coordinates)	
Array size, meters x meters	
Solar cell type	
Solar cell efficiency, %	
Expected power generation at Beginning of Life (BOL) and End of Life (EOL), watts	
Worst case sun incidence angle to solar panels during science mission, degrees	
Battery type	
Battery storage capacity, amp-hours	
Worst case battery Depth of Discharge (DOD), %	
Spacecraft bus voltage, volts	

5. Launch Service

The proposal shall discuss the launch option selection, the range of acceptable launch options, and orbit parameters. If proposing a partial mission (an instrument on another, host spacecraft), describe the plans for the host mission. Include information on the launch option margins and reserves (volume, mass, etc.).

In order to assess the launch services requirements, the following table of data shall be provided.

Table K-7. Required Launch Services Table

Launch Vehicle	Value, units
Launch Vehicle Performance, kg	
Shroud Volume, m ³	
Launch Site, name	
Injection Inclination Error, Degrees	
Injection Line of Nodes Error, Degrees	
Injection Altitude Error, km	

6. Manufacturing, Integration and Test

This section shall describe the manufacturing strategy to produce and verify the hardware/software necessary to accomplish the mission. It shall include a description of the main processes/procedures planned in the fabrication of flight hardware and software development; use of production personnel resources; incorporation of new technology/materials; and the preliminary test and verification program.

The approach, techniques, and facilities planned for manufacturing, integration, test and verification, and launch operations phases, consistent with the proposed schedule and cost, shall be described. A preliminary schedule for manufacturing, integration, and test activities shall be included. A description of the planned end items, including engineering and qualification hardware, shall be included. The use of any existing test facilities and processes shall be described.

7. Mission Operations, Ground, and Data System

This section shall discuss mission operations and the ground operations support required for the proposed investigation. The planned approach for managing mission operations and all flight operations support, including mission planning, shall be discussed. The proposal shall describe the approach to the development of the ground data system, including the use, if any, of existing facilities, including Government facilities. Include a block diagram of the Ground Data System (GDS) showing the end-to-end concept (acquisition through archiving) for operations and data flow to the subsystem level. Describe the use of standards, such as Consultative Committee for Space Data Systems (CCSDS) recommendations or commercial standards, on the space/ground communications link. Describe the software design heritage and software development approach and its relationship to the flight system software development. Discuss the proposed communications (or active sensing) frequency bands, and identify any issues for obtaining spectrum allocation license(s).

This section shall describe the planned approach for managing mission operations and all flight operations support, including mission planning. A description of the operational phase of the mission shall be included. Operational constraints, viewing requirements, and pointing requirements shall also be identified. Describe any special communications,

computer security, tracking, or near real-time ground support requirements, and indicate any special equipment or skills required of ground personnel.

The acquisition of data and the processing of that data both onboard the spacecraft and on the ground shall be described. The plan for processing the data after it has been delivered to the ground shall be discussed, including the method and format of the data reduction, data validation, and preliminary analysis. The process by which data will be prepared for archiving shall be discussed and the plan shall include a detailed schedule for the submission of data to the public domain in the proper formats, media, etc. Delivery of the data to the public domain shall take place in the shortest time possible.

In order to assess the mission operations and ground data systems, the following table of data shall be provided.

Table K-8. Mission Operations and Ground Data Systems Table

Down link Information	Value, units
Number of Data Dumps per Day	
Downlink Frequency Band, GHz	
Telemetry Data Rate(s), bps	
S/C Transmitting Antenna Type(s) and Gain(s), name and DBi	
Ground Station Selection(s), name	
Geographic locations of Ground Station(s) if not existing within STDN network, latitude & longitude	
Downlink Receiving Antenna Gain, DBi	
Bit Error Rate	
Downlink Modulation Format (e.g., PCM/PM/Bi-Ù, PCM/PSK/PM, BPSK, QPSK, etc.), name	
Error Detecting-Correcting Coding (e.g., convolutional, Reed-Solomon, concatenated, etc.), name	
Transmitting Power Amplifier Output, watts	

Uplink Information	Value, units
Number of Uplinks per Day	
Uplink Frequency Band, GHz	
Telecommand Data Rate, bps	
S/C Receiving Antenna Type(s) and Gain(s), name and DBi	

Specific features incorporated into the flight and ground system design that lead to low-cost operation shall be identified. The use of any existing mission operations facilities and processes shall be described, as well as any new facilities required to meet mission objectives.

Mission teams may use non-NASA or NASA navigation, tracking, control, communications, and other services. Information on space communications capabilities and costing is given in NASA's Mission Operations and Communication Services document available in the ESSP-3 AO Library. Address in your proposal spectrum allocation and licensing plans and issues. ISS payloads shall use the ISS communications systems that are provided at no cost and described in documents referenced in the ISS ESSP Research Opportunities document in the ESSP Project Library.

8. Plans to Resolve Open Technical Implementation Issues

This section shall describe the means by which the mission definition and preliminary design study will be performed. This section shall identify the key mission tradeoffs and options to be investigated during the Step-Two process and shall identify those issues, technologies, and decision points critical to the mission success. Identify and discuss any unresolved issues and potential risk areas to the proposed investigation. Identify your approach and schedule for resolving these issues and mitigating these risks. For example:

- NASA recognizes that teaming arrangements to implement the investigation may not be complete at the time of the proposal. If your teaming arrangements are not complete, demonstrate in your proposal that there are multiple implementation approaches for the spacecraft, launch vehicle, communications, and ground systems that will allow the successful implementation of the investigation.
- NASA seeks innovative missions but because of the short definition and development time, significant technology development may not be possible although technology infusion that enhances performance and reduces costs of the mission is encouraged. Investigations dependent on new technology, technology development, or technology enhancement shall identify the technology(s) along with risks involved and alternative approaches to resolve issues by completion of the Step-Two process. If necessary, identify a reasonable back-up approach that will assure the success of the investigation.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Mission Design and Table K-5**
- 2. Instrument Implementation**
- 3. Launch Service and Table K-7**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Mission Design and Table K-5**
- 2. Instrument Implementation**
- 3. Instrument Interface and Payload Integration**

- 4. Spacecraft, Spacecraft Technical Maturity Matrix (L-2b), Table K-6**
- 5. Launch Service and Table K-7**
- 6. Manufacturing, Integration and Test**
- 7. Mission Operations, Ground and Data System and Table K-8**
- 8. Plans to Resolve Open Technical Implementation Issues**

H. MANAGEMENT

The Management section shall summarize the management approach and the facilities and equipment required. This section sets forth the investigator's approach for managing the work, the recognition of essential management functions, and the overall integration of these functions. This section shall specifically discuss the decision-making process to be used by the team, focusing particularly on the roles, responsibilities and authority of the Principal Investigator (PI) and Project Manager (PM) in that process. The Management section shall provide insight into the organizations proposed for the work, including the internal operations and lines of authority, together with internal interfaces and relationships with NASA, team members, major subcontractors, and associated investigators. It also identifies the institutional commitment of all team members, and the institutional roles and responsibilities. The use of innovative processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged when cost, schedule, and technical improvements can be demonstrated. Given the relatively short development cycle for small missions such as ESSP, proactive management practices in identifying risks and technical issues and addressing them in a timely fashion is key to the team's success. The evaluation teams will pay specific attention to this aspect of proposals.

The PI is expected to be in charge of the proposed investigation, with full responsibility for its scientific integrity. The PI is responsible for assembling a team to propose and implement the investigation. Proposers may obtain services from any source. Please note that the level of detail required in the proposal is the same, independent of which organizations are part of the proposed mission team. Do not assume that contributed or NASA Center elements need not be explained. The PI is accountable to NASA for the scientific success of the investigation. Therefore, the PI shall be prepared to recommend mission termination if, in his/her judgment, the successful achievement of established science/applications objectives, as defined in the proposal, is no longer likely within the committed cost and schedule reserves.

Each selected investigation shall have a named Project Manager (PM) who reports to the PI and will oversee the technical implementation of the investigation. The role, qualifications, and experience of the PM shall be adequate to ensure that the technical and managerial needs of the investigation will be met. The PI can assume the PM responsibilities only if he/she can provide information indicating direct and relevant previous experience and can commit a large percentage of time during definition and development phases.

Dependent upon the number of Step-Two proposals received and available travel funding, NASA plans to use site visits to collect additional information for the Step-Two evaluation. Your Step-Two proposal must identify the single location for the site visit. NASA

recommends that you identify a site that you believe will best support demonstration of your readiness to implement the mission.

1. Management Processes and Plans

This section shall summarize the investigator's proposed management approach, tools and processes. Proposals shall encompass all aspects of the investigation from the initial studies through delivery of the data to the appropriate data repository and their analysis. The current version of NPG 7120.5, *Management of Major System Programs and Requirements*, delineates activities, milestones, and products typically associated with each of the phases and may be used as a reference in defining a team's mission approach. This document is included in the ESSP-3 AO Library (see Appendix B). Mission teams have the freedom to use their own processes, procedures, and methods, and the use of innovative processes is encouraged when cost, schedule, technical improvements, and reliability can be demonstrated.

The team shall propose performance metrics that will be incorporated into a successful team's contract. Violation of the agreed upon metrics may be cause for termination. The mission team shall develop a Work Breakdown Structure (WBS) that best fits its organizational approach and mission design concept. Successful innovative management approaches will be examined by Office of Earth Science for use within the Earth science/applications program.

NASA intends to allow the Principal Investigator and his/her team to use their own management processes, procedures, and methods to the fullest extent possible. However, to ensure mission success, there will be appropriate Government oversight and insight. Mission teams shall define the management, review and reporting approach and management tools for tracking cost, schedule and risk best suited for their particular teaming arrangement. Each team shall have a safety reliability and quality assurance program. These approaches shall be commensurate with the investigation's implementation approach, while retaining a simple and effective management structure necessary to assure the adequate control of development within the cost and schedule constraints. NASA will require the following reviews:

- System Requirements Review
- Preliminary Design Review
- Mission Design Review
- Confirmation Readiness Review
- Mission Confirmation Review
- Critical Design Review
- Pre-Environmental Review
- Pre-Ship/Operational Readiness Review
- Mission Readiness Review
- Flight Readiness Review

Additional Shuttle and ISS required safety reviews are described in the ISS ESSP Research Opportunities document in the ESSP Project Library.

The use of innovative processes, techniques, and activities by mission teams in accomplishing their objectives is encouraged; however, they shall be employed only when cost, schedule, or technical improvements can be demonstrated and specific enabling assumptions are identified. In addition, each team shall identify management processes and tools that may be useful to NASA in the management of its programs and projects.

Investigations that propose teaming arrangements, partnering and/or contributions to meet the mission objectives shall specifically address how the mission team will interrelate with the PI's organization and NASA, both organizationally and managerially. The capabilities that each member organization brings to the team, as well as previous experience with similar systems and equipment shall also be addressed.

2. Schedule

A project schedule to meet the proposed launch date shall be provided covering all phases of the investigation and identifying major milestones. The schedule shall include, as a minimum, proposed major project review dates including NASA required reviews; instrument development; spacecraft development; instrument-to-spacecraft integration and test; launch vehicle integration; and mission operations, algorithm development and data analysis. Schedule reserve shall be clearly identified.

3. Team Organization, Structure, and Experience

The roles, responsibilities, time commitment, experience of all key personnel, and institutional commitments shall be described in this section, with particular emphasis placed on the responsibilities assigned to the PI, the Project Manager and other key personnel. The proposal shall address any unique capabilities that each team member organization brings to the team, as well as previous experience with similar systems and equipment. In addition, information shall be provided which indicates what percentage of time will be devoted to the mission, the duration of service, and how changes in personnel will be accomplished. (Note: The experience of the PI and science team members does not need to be included in this section since it would have been addressed in the Science section.)

- **PRINCIPAL INVESTIGATOR** - The role(s), responsibilities, and time commitment of the single Principal Investigator shall be discussed. Provide a reference point of contact including address and telephone number.
- **PROJECT MANAGER** - The role, responsibilities, time commitment, credentials and experience of the Project Manager shall be provided. The Project Manager shall report directly to the Principal Investigator. In addition, the Project Manager shall be named in the Step-Two Proposal. Provide a reference point of contact including address and telephone number.

- OTHER KEY PERSONNEL - The roles, responsibilities, time commitments, and experience of the Co-Investigators and other key personnel in the investigation shall be described.

The management organizational structure of the investigation team shall be described in the proposal. The proposal shall identify the teaming approach to be used and describe the responsibilities of each team member and their contributions to the investigation. The work of these individuals and institutions shall be accounted for in the cost elements breakdowns provided in the Cost section.

Of special interest is the organizational approach and plan for efficient and effective management of the multi-organizational interfaces between cooperating partners and team members. Particular emphasis shall be placed on the organizational relationship between the PI and the PM. The capability of the team to respond quickly and effectively to problems and inter-organizational conflicts shall be demonstrated. Proposed lines of communication and authority shall be demonstrated.

The contractual/financial responsibilities and relationships of all team partners, including contributions, shall be described. The mechanisms (contracts, subcontracts, cooperative agreements, memoranda of agreement, etc.) by which organizations commit to participate as partners on a proposing team shall be clearly identified. Include a description of incentives and fee strategy, where appropriate, and their rationale. The proposal letters of endorsements shall include the signature of an official from each organization represented on the team or contributing to the investigation who is authorized to commit that organization to the proposed investigation. Failure to include any such authorization may be grounds for rejection of the proposal. Foreign organizations and funding sources participating as team partners shall also meet this requirement. Information on procurement of long lead items and proposed major and critical subcontracts, including procurement activities of all team partners, shall be provided. The information shall consist of, at a minimum, name of the item, scope of the work to be performed, name and location of supplier or subcontractor, proposed award schedule, deliverable items and delivery schedule, proposed performance assurance requirements, and contingency plans if a supplier or subcontractor fails to perform. Describe the relationships and controls you will exercise over suppliers and subcontractors from both cost and schedule standpoints.

The experience (successes *and* failures) of team partners in managing projects of similar scope, including cost and schedule performance within the last ten years shall be discussed.

4. Risk Management

This section shall describe the approach to, and plans for, risk management to be taken by the team, both in the overall mission design and in the individual systems and subsystems. Particular emphasis shall be placed on describing how the various elements of risk will be managed to ensure successful accomplishment of the mission within cost

and schedule constraints. Included in this discussion of risk management shall be risk mitigation plans for any new technologies and the need for any long-lead items that need to be placed on a contract before the start of the development phase to ensure timely delivery. In addition, any manufacturing, test, or other facilities needed to ensure successful completion of the proposed investigation shall be identified. In the event risks cannot be managed successfully and mission objectives shall be revised toward the Minimum Science Mission, this section shall describe the descope options available to the team, their phasing, and their effect on mission performance relative to the previously defined Baseline Science Mission. If the proposed Baseline and Minimum Science Missions are equivalent, proposers shall clearly articulate the rationale for this decision and identify viable contingency options (e.g., additional reserves, etc.). This section shall identify the latest possible dates at which descope options may be implemented and the procedure by which they would be accomplished.

5. Mission Assurance and Safety

This section shall describe the process by which mission success is assured and achieved. This section shall describe mission assurance plans to ensure product quality, including specific plans for reviews, identification of trade studies, plans to incorporate new technology, problem/failure resolution, inspections, quality assurance, reliability, parts selection and control, and software validation activities compatible with industry best practices, ISO 9000 quality standards, American National Standard, "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation, and Servicing," ANSI/ASQC Q9001-1994, and the Mission Assurance Guidelines and Requirements in Appendix H. A table similar to that shown in Appendix L, Figure L-5 shall be used to illustrate compatibility of the proposer's own mission assurance processes with the Mission Assurance Guidelines and Requirements.

In addition, this section shall describe the process by which safety standards are met and hazards mitigated. The mission team member responsible for implementing the system safety program for the proposed mission shall be identified. Past experiences of this mission team member in implementing system safety program from previous missions shall be described. This section shall also describe all safety plans and practices to be used in mission development. These plans and practices shall be compliant with the Flight and Ground Safety Requirements in Appendix J. This section shall also address the mission's compliance with NASA Safety Standard (NSS) 1740.14, "Guidelines and Assessment Procedures for Limiting Orbital Debris", which can be found in the ESSP Project Library (see Appendix B).

6. Facilities and Equipment

All major facilities, laboratory equipment, and ground-support equipment (GSE) (including those of the team's proposed contractors and those of NASA and other U.S. Government agencies) essential to the mission in terms of its system and subsystems shall be indicated, distinguishing insofar as possible between those already in existence and those that will be developed in order to execute the investigation. The outline of new

facilities and equipment shall also indicate the lead-time involved and the planned schedule for construction, modification, and/or acquisition of the facilities. The proposal shall also include documented availability of proposed assets.

7. Plans to Resolve Open Management Issues

Identify and discuss any unresolved issues. Include your planned approach and schedule for resolving these issues.

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Management Processes and Plans**
- 2. Schedule**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Management Processes and Plans**
- 2. Schedule**
- 3. Team Organization, Structure, and Experience**
- 4. Risk Management**
- 5. Mission Assurance and Safety**
- 6. Facilities and Equipment**
- 7. Plans to Resolve Open Management Issues**
- 7. Site visit location**

I. COST AND COST ESTIMATING METHODOLOGY

Outside contributions to the mission are encouraged but are not required and there are no limits on the extent of those contributions. Contributions can be of cash, property or services on a no-exchange-of-NASA-funds basis. NASA civil service or NASA contractor resources may not be contributed unless separately funded by a complementary effort. NASA Center and NASA contractor participation **shall** be on a full-cost accounting basis, (but see paragraph M.1.a below).

Appendix L, Figure L-10 gives the NASA inflation index for calculating real year dollars.

For Step-One, this section shall summarize the total mission cost (in real year U.S. Dollars) and cost estimating methodology, including a discussion of any contributions. These costs are not intended to be detailed bottoms-up estimates but are a PI's best estimate of the expected cost of the elements in the table, and will be used in the evaluation process to determine cost risk as well as NASA's funding requirements. This estimate is not binding and may be adjusted in the Step-Two proposal. Cost is not an explicit part of the evaluation, and cost and cost estimating details are not required. However, NASA will estimate the cost of the mission, using information provided in the proposal in order to assess the risk of exceeding the ESE Mission Cost ceiling. The more information that is provided in the Step-One proposal, the easier it will be for NASA to make an accurate prediction of cost risk.

NASA reserves the right to recommend a mix of larger and smaller missions proceed to Step-Two for programmatic reasons.

For Step-Two proposals: The expected NASA Mission Cost (NMC) and Total Mission Life Cycle Cost (TMLCC) in real year dollars shall be provided as indicated in the table below. Provide the cost and cost estimating details in a separate volume as described later in this Appendix.

Table K-9. Total Mission Life Cycle Cost (Real Year Dollars)

Cost Element	FY2001	FY2002	FY2003	FY2004	FY2005	Total
Mission Development:						
Proj. Mgmt/Misn. Analysis/Sys. Eng.						
Instrument A						
Instrument B						
Instrument ...						
Subtotal - Instruments						
Spacecraft bus						
Science Team Support						
Ground Data System Development						
Education (1)						
Mission Operations Development Activities						
Integration, Assembly and Test						
Instrument Reserves						
Spacecraft Reserves						
IA&T Reserves						
Other Reserves						
Subtotal Reserves						
Total Mission Development						
Launch and Mission Operations						
Payload Integration to Launch Vehicle						
Mission Operations and Data Acquisition						
Data Analysis, Archival, and Dissemination						
Launch and Mission Operations Reserves						
Total Launch and Mission Operations						
Launch Vehicle and Services						
Total NASA Cost						
Contributions (2)						
1)						
2)						
...						
Total Contributions						
Total Mission Cost =						

(1) Education costs that are not included within other cost elements

(2) Specify each item on a separate line, identifying Contributor and what is being contributed

Note within the constraints of the page limits:

Step-One proposals at minimum shall cover the following item(s).

- 1. Summarize the total mission cost and cost estimating methodology including a discussion of any contributions**

Step-Two proposals at minimum shall cover the following item(s).

- 1. Summarize the total mission cost and cost estimating methodology including a discussion of any contributions**
- 1. Complete total mission cost table above (must be consistent with Appendix K, Section M Cost and Cost Estimating Details).**

J. EDUCATION

Necessary elements to be described in the Education plan include:

1. Rationale - Define the educational need the plan will meet. Identify the ESE science, applications, technology, or educational thematic element(s) being addressed. What are the interesting science questions that lie behind the project? Why are they interesting? What can be said about the connection of this work to societal needs?
1. Goals - Define the project goals and objectives. What are three to five basic “take-home messages”? What are the anticipated impact and outcomes? How do they contribute to the NASA’s Earth Science Research Priorities described in Section 4.0 of NASA’s Earth Science Enterprise Research Strategy 2000-2010 (Appendix A)? How will successful activities be sustained beyond the project duration and an on-going NASA investment?
1. Audience - Clearly define the target audience. Do primary and secondary audiences exist? What is known about the audience’s learning or operating levels and styles? What does the audience know about the topic? What misconceptions might they have about the topic that might influence the learning or communication outcomes? Estimate the size of the target audience.
1. Activity - Thoroughly describe the proposed project. Describe how the project will be accomplished and the goals achieved. Include a timeline of the developmental period.
1. Dissemination - Describe how the activity or project will be broadly disseminated. Dissemination involves the marketing or announcing the activity, as well as developing the mechanisms to ensure that the intended audience will use the activity.
1. Evaluation - Describe how the project will be evaluated. Formative: What procedures will be used during the developmental phase of the project to assure a good product when it is completed? Who will do this work? Summative: How will it be determined that the educational goals have been achieved? Describe the means by which the impact of the project on the target audience will be examined? Who will do the evaluation?
1. Management - Identify and describe the personnel who will be involved in the development and production of the activity. What staff, advisors or external partnerships will be required? How is management of the educational activities configured in the overall mission project management? Provide staffing details for all elements of the education plan.

1. Budget – Provide appropriate details on cost. What potential support from non-NASA sources exists? If so, what might these be and to what extent?

Note within the constraints of the page limits:

Step-Two proposals at minimum shall cover the following item(s).

1. Rationale
2. Goals
3. Audience
4. Activity
5. Dissemination
6. Evaluation
7. Management
8. Budget

K. OTHER OPPORTUNITIES

1. Small, Small Disadvantaged, and Small Veteran-Owned Business, and Minority Institution Involvement

This section of the Step-Two proposal shall discuss a subcontracting plan for Small Disadvantaged, Women-Owned, and Veteran-Owned Small Businesses, Historically Black Colleges and Universities, Other Minority Universities and Institutions, and certified Historically Underdeveloped Business Zone (HUBZone) businesses involvement in the implementation of the investigation. The subcontracting approach shall be discussed and the subcontracting goals stated.

The proposing institution(s) shall agree to use their best efforts to assist NASA in achieving its goal for the participation of small disadvantaged businesses, women-owned small businesses, veteran-owned small businesses, certified HUBZone businesses, Historically Black Colleges and Universities (HBCUs), and Other Minority Universities (OMUs) including Hispanic serving institutions and Tribal colleges and Universities in NASA procurements. Investment in these organizations reflects NASA's commitment to increase the participation of minority concerns in the aerospace community and is viewed as an investment in our Nation's future. Proposals shall recognize this requirement and shall discuss the intent to include small disadvantaged businesses and minority institutions.

NASA contracts resulting from this solicitation which offer subcontracting possibilities, exceed \$500,000, and are with entities other than small business concerns, will contain the clause at FAR 52.219-9. Offerors who are selected under the Step-Two Process under this AO, and who meet the foregoing conditions, will be required to negotiate appropriate subcontracting plans. A proposed subcontracting plan shall be provided in this section and will be evaluated as part of the Step-Two Process.

The institutions eligible to be considered as Minority Institutions for the purposes described in this section are Historically Black Colleges and Universities (HBCUs) and Other Minority Universities (OMIs) as defined and certified by the Department of Education. A list of U.S. accredited post secondary minority institutions can be found at the Internet address <http://www.ed.gov/offices/OCR/99minin.html>.

2. Commercial Opportunities

U.S. economic and technical competitiveness achieved through partnerships between public sector programs and the private sectors are important to the U.S. Also, many social benefits are derived from a strong U.S. economy. Therefore, proposals to enhance commercialization opportunities are encouraged. Discuss in this section of the Step-Two proposal the nature of the commercial opportunity(ies) including a description of the U.S. company(ies) involved, the nature of the commercial involvement (for example, launch services, instrument, other product or service), and the market to be addressed. The social benefits and enhanced U.S. economic and technical competitiveness achieved through partnerships between the public sector programs and the private sector shall also be discussed. If the commercial opportunity involves use of data that will be acquired by the mission, any data rights required by the private sector partner shall also be defined (see section 3.2.3). Specify any specific examples of commercialization.

3. Plans to Resolve Open Other Opportunity Issues

Identify and discuss any unresolved issues. Include your planned approach and schedule for resolving these issues.

Note within the constraints of the page limits:

Step-Two proposals at minimum shall cover the following item(s).

- 1. Small, Small Disadvantaged, Woman- and Veteran-Owned Small Businesses, and Minority Institution Involvement**
- 2. Commercial Opportunities**

L. APPENDICES

The following additional information is required to be supplied with the proposal as Appendices and, as such, will not be counted within the specified page limit.

1. Resumes. Provide resumes or curriculum vitae for all named team members identified in the proposal and on form Section B – Investigation Summary Form II. Resumes or curriculum vitae shall be no longer than one page in length.
2. Statement of Work (SOW) and Funding Information: For investigations managed from non-Government institutions, provide a SOW. For investigations managed from Government institutions, provide a SOW as if the institution were non-Government. The SOW shall include general task statements for Phases Mission Definition and Design, Mission Detailed Design, Mission Development and Launch, and Mission

Operations and Data Analysis, Archival and Dissemination for ESSP Investigations, and performance metrics. All SOWs shall include the following, as a minimum: Scope of Work, Deliverables (including science/applications data), and Government Responsibilities (as applicable). SOWs need not be more than a few pages in length. Funding information and documentation shall be provided that identifies how funds are to be allocated among the organizations supporting the investigation. Funding documents shall be provided that are necessary to allocate the correct amount of funds to each organization supporting the investigation.

3. Certifications: The following certifications shall be provided with the proposal.
 - a) Civil Rights Certification form or NASA Form 1206, Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs (see Appendix Q).
 - b) Certification Regarding Lobbying (see Appendix P).
 - c) Certification Regarding Debarment, Suspension, and Other Responsibility Matters Primary Covered Transactions (see Appendix O).

Certification originals shall be provided with the original proposal. Copies of all certification shall be provided in all proposal copies.

4. Preliminary Mission Definition and Requirements Agreement. A draft Mission Definition and Requirements Agreement shall be provided. An example of a Mission Definition and Requirements Agreement is provided as Appendix R.
5. Draft Incentive Plan. A draft Incentive Plan shall be included with the Step-Two Proposal. This Incentive Plan shall outline contractual incentive features for all major team members. Incentive Plans shall include both performance and cost incentives, as appropriate.
6. Relevant Experience and Past Performance. Relevant experience and past performance (successes and failures) of the major team partners in meeting cost and schedule constraints in similar projects within the last ten years shall be discussed. A description of each project, its relevance to the proposed investigation, cost and schedule performance, and points of contact (including addresses and phone numbers), shall be provided.
7. Draft International Agreement(s). Draft International Agreement(s) are required for all non-domestic partners in the investigation. Elements to be included in the International Agreement can be found in Appendix F.
8. NASA Principal Investigator Proposing Teams. Proposals submitted by NASA employees as Principal Investigators shall contain the following information concerning the process by which non-Government participants were included in the proposal. The proposal shall (i) indicate that the supplies or services of the proposed non-Government participant(s) are available under an existing NASA contract; (ii)

make it clear that the capabilities, products, or services of these participant(s) are sufficiently unique to justify a sole source acquisition; or (iii) describe the open process that was used for selecting proposed team members. While a formal solicitation is not required, the process cited in (iii) above shall include at least the following competitive aspects: notice of the opportunity to participate to potential sources; submissions from and/or discussions with potential sources; and objective criteria for selecting team members among interested sources. The proposal shall address how the selection of the proposed team members followed the objective criteria and is reasonable from both a technical and cost standpoint. The proposal shall also include a representation that the Principal Investigator has examined his/her financial interests in or concerning the proposed team members and has determined that no personal conflict of interest exists. The proposal shall provide a certification by a NASA official superior to the Principal Investigator verifying the process for selecting contractors as proposed team members, including the absence of conflicts of interest.

9. Contractual Requirements. In order to expedite mission contract awards, proposers are required to propose mission contract terms, conditions and deliverables as defined below.

Each proposer shall submit a list of contract deliverables for Mission Definition and Preliminary Design, and Phases Mission Detailed Design, Mission Development and Launch, and Mission Operations and Data Analysis, Archival, and Dissemination option (see Appendix S). Example contracts including deliverable lists (Section B.1 of the contract) for current ESSP missions are available in the ESSP Project Library (see Appendix B). Submitted contract deliverable lists shall be consistent with the format of these referenced examples.

Proposers shall review the generic contract terms and conditions for educational institutions or commercial organizations (whichever is appropriate) in the ESSP-3 AO Library (see Appendix B). Proposers shall specifically identify any exceptions and/or proposed changes to the contract terms and conditions (i.e., clauses) contained within the appropriate contract document. If no exceptions are taken, a statement to that effect shall be included. All proposed contractual documentation, if accepted by NASA, shall be considered executable upon selection. If no exceptions are taken, the sample generic contractual documents will be used as the basis for selected mission contract formulation. NASA reserves the right to negotiate all contract terms and conditions following mission selection.

10. Letters of Endorsement.. Only a one page summary of the proposed endorsements shall be included in the Step-One proposal. In Step-Two, in addition to the one page summary, the letters of endorsement shall be provided. Letter are expected from the following:
 - Participants/Organizations in the proposal including NASA participants/organizations,

- All organizations offering goods and/or services on a no-exchange-of-NASA-funds basis,
- Foreign organizations providing hardware or software to the investigation,
- Launch Service provider, if the launch service is not provided through a NASA contract.

Letters of endorsement shall be signed by institutional and Government officials authorized to commit their organizations to participation in the proposed investigation. All letters shall be compiled in Appendix 10 of the Step-Two proposal. Additional required information can be found in Appendix K, Section E - Endorsements.

The following information may be provided.

1. References List: Proposals may provide, as an appendix, a list of reference documents and materials used in the proposal. The documents and materials themselves cannot be submitted, except as a part of the proposal, unless the reference is not in publication and therefore not generally available.
2. Acronyms List: Proposals may provide, as an appendix, a list of acronyms used in the proposal. Acronym use should be kept to a minimum in the proposal.

NO OTHER APPENDICES ARE PERMITTED.

Note:

Step-One proposals at minimum shall cover the following item.

1. **Resumes**

Step-Two proposals at minimum shall cover the following items

1. **Resumes**
2. **Statement of Work (SOW) and Funding Information**
3. **Certifications**
4. **Preliminary Mission Definition and Requirements Agreement**
5. **Draft Incentive Plan**
6. **Relevant Experience and Past Performance**
7. **Draft International Agreement(s) (if applicable)**
8. **NASA Principal Investigator Proposing Teams (if applicable)**
9. **Contractual Requirements**
10. **Letters of Endorsement**

M. COST AND COST ESTIMATING DETAILS

This section is only required for Step-Two Proposals and shall be placed in a separate volume from the rest of the proposal. See Table K-1 and Table K-2 for additional information. This section shall be consistent with the material described in Section I of this Appendix.

1. Basis of Cost Estimate

The proposals shall include the Total Mission Life Cycle Cost (in real year dollars), which includes the NASA Earth Science Enterprise Cost cap, the NASA Launch Cost, and all contributed costs. The Total Mission Life Cycle Cost includes but is not limited to the following:

- Mission conceptual study, definition and development of all flight and ground hardware and software, and operations of the mission
- Non-satellite measurements necessary for calibration or validation of observations
- Other mission support
- Development, operation, refinement, maintenance, documentation, and publication of all required algorithms to accomplish the mission
- Processing, archiving, distribution, maintenance, documentation, and information management of all mission derived data products to permit community-wide access
- Publication of results in refereed science literature
- Delivery to NASA, at mission end, all data supporting information and available results
- Cost of the education requirements
- Projects reserves
- Acquisition of launch services and launch (identified separately)

These costs shall be consistent with the project requirements described in Sections 3, 4, and 5 of the AO. The amount to be costed in each fiscal year shall be identified by providing the data in Appendix L, Figures L-6 through 9. The top portion of Appendix L, Figure L-7 requests cost data relative to the NASA ESE Cost. The lower portion addresses contributions. Appendix L, Figure L-10 gives the NASA inflation index to be used to calculate real year dollars.

Identify and justify the methodology used to estimate the cost, for example, specific cost model, past performance, cost estimating relationships from analogous missions, and assumptions. Describe the budget reserve strategy, including budget reserve levels as a function of mission phase.

a. Full Cost Accounting

NASA services, facilities, and equipment can be proposed. Where NASA-provided services, facilities and equipment are used, NASA Civil Service labors and supporting NASA Center infrastructure must be costed on a full cost accounting basis. If NASA guidance for full cost accounting has not been fully developed by the closing date for proposal submission, NASA Centers may submit full cost proposals based on the instructions in the NASA Financial Management Manual, Section 9091-5, "Cost Principles for Reimbursable Agreements," or based on their own Center-approved full cost accounting models. Other Federal Government elements of proposals must follow their agency cost accounting standards for full cost. If no standards are in effect, the proposers must then follow the Managerial Cost

Accounting Standards for the Federal Government as recommended by the Federal Accounting Standards Advisory Board.

b. NASA ESE Cost

The NASA ESE Cost is the funding that the NASA Earth Science Enterprise would be expected to provide to the mission team over the course of the investigation in real year dollars, beginning with initial selection and ending with the conclusion of data analysis and distribution of data to the scientific community. Examples of costs to be included are any upper stages; flight hardware, including science/applications instrumentation and spacecraft; payload adapter; education and outreach activities; new technology; subcontracting costs (including fees); science/applications teams; all personnel required to conduct the investigation, analyze and publish results, and deliver data in archival format; insurance; ground data system; labor (contractor); NASA Civil Servant costs; reserves; and contract fees. A mission reserve will not be maintained by Office of Earth Science; therefore, each mission must include its own credible mission phased reserve proportional to the development risk. The NASA Earth Science Enterprise costs for the mission is capped at \$125 M (real year dollars), excluding launch vehicle and launch services, and proposers are strongly encouraged to propose lower cost missions. The NASA Mission Cost, which is the sum of the ESE Mission Cost and the NASA Launch Services Cost, is a consideration in the selection of investigations and in the continuing assessment of ongoing missions.

c. NASA Launch Services Cost

Launch services are discussed in section 3.1.4 of the AO. Launch services cost is defined as that portion of the proposed Total Mission Life Cycle Cost to be funded by NASA for the acquisition of a launch vehicle and the services necessary for launch. Elements of this cost include the launch vehicle itself, including any upper stages, payload fairings, propellants, and labor and materials needed for launching. Launch Services cost is not part of the NASA Earth Science Enterprise Cost ceiling of \$125 million discussed elsewhere in these instructions. Proposers must still include the estimated cost of launch services in the cost tables K-10, above, and Figures L-7 and L-8 below for completeness. . Elements that are to be included in payload integration costs and are not part of launch services include payload adaptors, cabling and connectors to connect the payload to the launch vehicle, and labor, equipment, and materials necessary for health monitoring and maintenance of the payload prior to launch.

d. Goods and/or Services Offered on a No-Exchange-of-NASA-Funds Basis

Contributions of any kind, whether cash or non-cash (cash, property and/or services) to ESSP by organizations other than the Office of Earth Science are encouraged but not required. Values for all contributions of property and services shall be established in accordance with applicable cost principles. Such contributions may be applied to any part or parts of a mission. A letter of endorsement that contains a statement of

financial commitment from each responsible organization offering to contribute, and the amount of the contribution in U. S. Dollars to the investigation must be submitted with the proposals for all U.S. components. For foreign components of proposals, see Section 3.3.

The cost of contributed hardware or software shall be estimated as either: (1) the cost associated with the development and production of the item if this is the first time the item has been developed and if the mission represents the primary application for which the item was developed; or (2) the cost associated with the reproduction and modification of the item (i.e., any recurring and mission-unique costs) if this is not a first-time development. If an item is being developed primarily for an application other than the one in which it will be used in the proposed investigation, then it may be considered as falling into the second category (with the estimated cost calculated as that associated with the reproduction and modification alone). In this case, document the commitment to complete the development on the part of the organization funding the other application.

The cost of contributed labor and services shall be consistent with rates paid for similar work in the offeror's organization. The cost of contributions shall not include funding spent before the start of the investigation. The value of materials and supplies shall be reasonable and shall not exceed the fair market value of the property at the time of the contribution. NASA will evaluate the realism of all costs regardless of the proposed source.

2. Reserves and Margins

Include a discussion of reserves, margins, and descope options, including the time phasing and critical decision points. Justify the level and allocation of these reserves, margins and descope options based on the level of technical and programmatic risk for your investigation. Discuss the management of the reserves and margins, including whom in the management organization manages the reserves and when and how the reserves are released. Definitions and examples of reserves and margin are found in Figure L-11 in Appendix L.

3. Plans to Resolve Open Cost Issues

Identify and discuss any unresolved issues. Include your planned approach and schedule for resolving these issues.

Proposals submitted in response to this AO must be of sufficient cost detail to enable NASA to make a fair and reasonable assessment of the NASA Mission Cost (NMC) and the Total Mission Life Cycle Cost (TMLCC) of the proposed Baseline Science Mission. The term “cost” is defined as dollars actually expended for accomplishment of the mission during a given time period. Cost differs from “funding”, which is defined in the Funding Profile section below. The NMC represents the NASA-funded portion of the mission. The TMLCC is the total amount of resources used to produce the mission; that is, the NMC plus all non-

NASA-funded contributions. This includes direct and indirect costs that contribute to the mission, regardless of funding sources. The NMC for an ESSP mission must include the full cost of all civil service support to the mission, including science co-investigators, technical advisors, facilities, etc., unless contributed by their agency. If contributed, these resources must be included in the TMLCC.

Direct costs that can be specifically identified with an ESSP mission include: (a) salaries and other benefits for employees who work directly on the mission, (b) materials and supplies used directly in support of the mission; (c) various costs associated with office space, equipment, facilities, and utilities that are used exclusively to produce the mission; and (d) costs of goods or services received from other segments or entities that are used to produce the ESSP mission.

Indirect costs include resources that are jointly or commonly used to produce two or more types of products but are not specifically identifiable with any of the products. Typical examples include labor overheads, material handling, cost of money (COM), general administration, general research and technical support, security, rent, employee health and recreation facilities, operating and maintenance costs for buildings, equipment, and utilities.

Cost estimating procedures shall be based upon generally accepted cost accounting principles and practices and must be in accordance with the proposer's approved accounting system. Additional information on cost principles, procedures, and definitions are found in the Federal Acquisition Regulations (FAR) in parts 30 and 31.

The methods by which the cost estimates are derived shall be described. If an estimate is based on heritage, the performance and cost parameters that the proposed system has in common with the previous or existing system shall be provided. An analysis of the impact of the referenced heritage on the risk of the proposed mission and on the proposed mission cost estimate shall also be provided. If cost models are used, a description of the model and the assumptions used to derive the cost estimates shall be documented. Identify any "discounts" assumed in the cost estimates for business practice initiatives or streamlined technical approaches. Describe how these have been incorporated in the cost estimate.

Copies of applicable forward pricing rate agreements shall be provided. Costing of Federal Government elements of proposals must follow the agency cost accounting standards for full cost (see paragraph M.1.a, above).

All costs, including foreign contributions, must be in U.S. Government real year dollars. Real year dollars are current fiscal year (FY) dollars adjusted to account for inflation in future years; in other words: real year dollars are what you will have to actually spend in each future year. The inflation rate index provided in Appendix L, Figure L-10 shall be used to calculate all real year dollar amounts unless an industry forward pricing rate is used and documented. Where cost phasing is requested, the cost plan shall provide data by U.S. Government fiscal year (October 1 - September 30) for phases Mission Detailed Design through Mission Operations and Data Analysis, Archival, and Dissemination and by Government fiscal quarter for phase Mission Definition and Preliminary Design. Requests

for cost by “Phase” refer to Phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination as defined in Section 3.2 of this AO. Costs shall be broken down to the system or subsystem level, as requested, in accordance with the proposed Work Breakdown Structure (WBS), which shall be included for reference.

Separate Phase Cost Breakdown by WBS and Major Cost Category and Government fiscal year (fiscal quarter for phase Mission Definition and Preliminary Design) shall be provided at the appropriate WBS level for each major mission organization (i.e., the PI, each NASA-funded team member, each contributor, and each subcontract exceeding \$500,000) as defined below. In addition, a roll-up Summary of Elements of Cost shall be provided for each organization. Appendix L, Figure L-8 is provided as a template for these costs. This format can be expanded to show additional phases and fiscal years. Major categories of cost shall be provided at the subsystem level for the flight system, including the science instruments, and at least the system level for all other items. The value of reserves shall be included and separately identified by WBS at the system level. A mission level Summary of Elements of Cost for the total ESE Cost, NASA Launch Services Cost, and the TMLCC, which represents the total of all separate Summaries, shall also be provided, but need not be broken down by skill categories, overhead centers, etc.

The Summaries of Elements of Cost shall contain the following direct and indirect elements.

Note: these are the “program cost elements” mentioned by footnotes for Figures L-6, L-7 and L-9.

- **DIRECT LABOR HOURS** - Show productive hours by individual skill categories for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **DIRECT LABOR COSTS** – The labor costs shall be itemized by skill categories for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **LABOR OVERHEAD** - Overhead shall be itemized by cost centers (engineering, manufacturing, etc.) for phase Mission Definition and Preliminary Design and as totals by fiscal year for phases Mission Detailed Design through Mission Operations and Data Analysis, Archival, and Dissemination. Rates shall be documented for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **SUBCONTRACTS** - Supporting information shall be provided for all subcontracts exceeding \$500,000 for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination. This detail shall include name/address, cost, fee/profit, type of contract, number of quotes solicited/received, basis of selection, affiliation with the Prime, type of business, type of cost and price analysis accomplished, concise basis of estimate, and basis of selection.

- **MATERIALS** - Supporting detail for major vendors (exceeding \$500,000) in phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination shall include WBS element, fiscal year or quarter, description, vendor name/address, quantity, and current/proposed unit prices. Material burden rates shall be documented for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **TRAVEL** - Travel shall be summarized as totals for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination. A table shall be included that provides the basis of estimate for travel costs. This shall include, but is not limited to, number of travelers, destinations, number of days, airfare cost, rental car cost, per diem costs (hotel, meals, etc.), etc.
- **OTHER DIRECT COSTS** - Other direct costs shall be summarized as totals for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **GENERAL AND ADMINISTRATIVE (G&A) EXPENSE** - G&A expense represents the institution's general and executive offices and other miscellaneous expenses related to business. G&A expense shall be itemized by cost pool for the Mission Definition and Preliminary Design phase and summarized as totals for phases Mission Detailed Design through Mission Operations and Data Analysis, Archival and Dissemination. Rates shall be documented for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **COST OF MONEY (COM)** - COM represents interest on borrowed funds invested in facilities. COM shall be itemized by indirect pools and overhead centers for the Mission Definition and Preliminary Design phase and summarized as totals by fiscal year for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination. Rates shall be documented for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **PROFIT/FEE** - Document the basis, rate, and amount of fee for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.
- **ESCALATION FACTORS** - Document the escalation factors used to determine real year dollars for phases Mission Definition and Preliminary Design through Mission Operations and Data Analysis, Archival, and Dissemination.

In addition to the Summaries of Elements of Cost, the proposer shall provide the following mission level information:

- Total costs will always equal total funding at program completion.

- **SUMMARY OF COST RESERVES** - A time phased summary of cost reserves shall be presented by Phase for all WBS elements that contain reserve. The proposed cost by element, the amount of reserve for each element, and the reserve as a percentage of the TMLCC for each element shall be provided. A rolled up summary of cost reserves, which represents a total of reserves for all WBS elements shall also be provided.
- **DESCOPE OPTIONS** - The cost savings associated with all descope options presented in the Management section shall be time-phased and provided for all mission phases.
- **FUNDING PROFILE** - Provide a profile of required NASA-funding by fiscal year. The funding profile is derived from the cost profile that is the basis of the proposal. The funding for a given fiscal year is determined from the estimated costs in that year, less the funding carried over from the previous fiscal year, plus the forward funding needed to cover the costs of the first month in the following fiscal year, plus the forward funding required for “unfilled orders”. Unfilled orders refer to long lead items for which funding and costing takes place in different Government fiscal years. Because of forward funding, costs will not equal funding in any given fiscal year. Total costs shall equal total funding at program completion.

Appendix L, Figure L-7 is provided as a template for the TMLCC phasing by fiscal year. Resources provided as contributions by international or other partners shall be included and clearly identified as separate line items

Note:

Step-Two proposals at minimum must cover the following items

- 1. Complete Section M required**

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AO 01-OES-01 ESSP Announcement of Opportunity	Proposal No. _____ <i>NASA Use Only</i>
Principal Investigator	
<i>Title</i>	<i>First Name Middle Name Last Name</i>
Department	
Company/Institution	
Street Address	City/Town
State	Zip/Postal Country
Telephone	Fax E-Mail Address
Proposal Title	
Science/Application Research Supported <input type="checkbox"/> Earth System Variability and Trends <input type="checkbox"/> Primary Forcings of the Earth System <input type="checkbox"/> Earth System Responses and Feedback Processes <input type="checkbox"/> Other (Specify) _____ (As listed in NASA's Earth Science Research Strategy for 2000-2010 (Appendix A))	
Scientific Theme, Application Research or Commercial Development topic: _____	
<i>Abstract (Limit 150 words)</i>	

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Earth System Science Pathfinder (ESSP) AO Form
Section B - Investigation Summary Form II

AO 01-OES-01 ESSP Announcement of Opportunity	Proposal No. _____ <i>NASA Use Only</i>
Principal Investigator <div style="display: flex; justify-content: space-between; margin-top: 20px;"> <i>Title</i> <i>First Name</i> <i>Middle Name</i> <i>Last Name</i> </div>	
Proposal Title	
Mission Mode <input type="checkbox"/> Complete Mission	Cost (real year dollars) NASA ESE Cost \$ _____ NASA Mission Cost \$ _____ Total Mission Life Cycle Cost \$ _____
Anticipated Launch Vehicle:	Anticipated Launch Date:
Anticipated Instrument Carrier (if applicable):	
Press Release Abstract (50 words)	

Co-Investigator(s)

Name	Institution	Responsibility	Funded	E-Mail

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APPENDIX L

CHARTS AND TEMPLATES

Technology Definitions

Technology Readiness Levels (TRL), Research vs. Development, Relevant Cross-cutting Processes

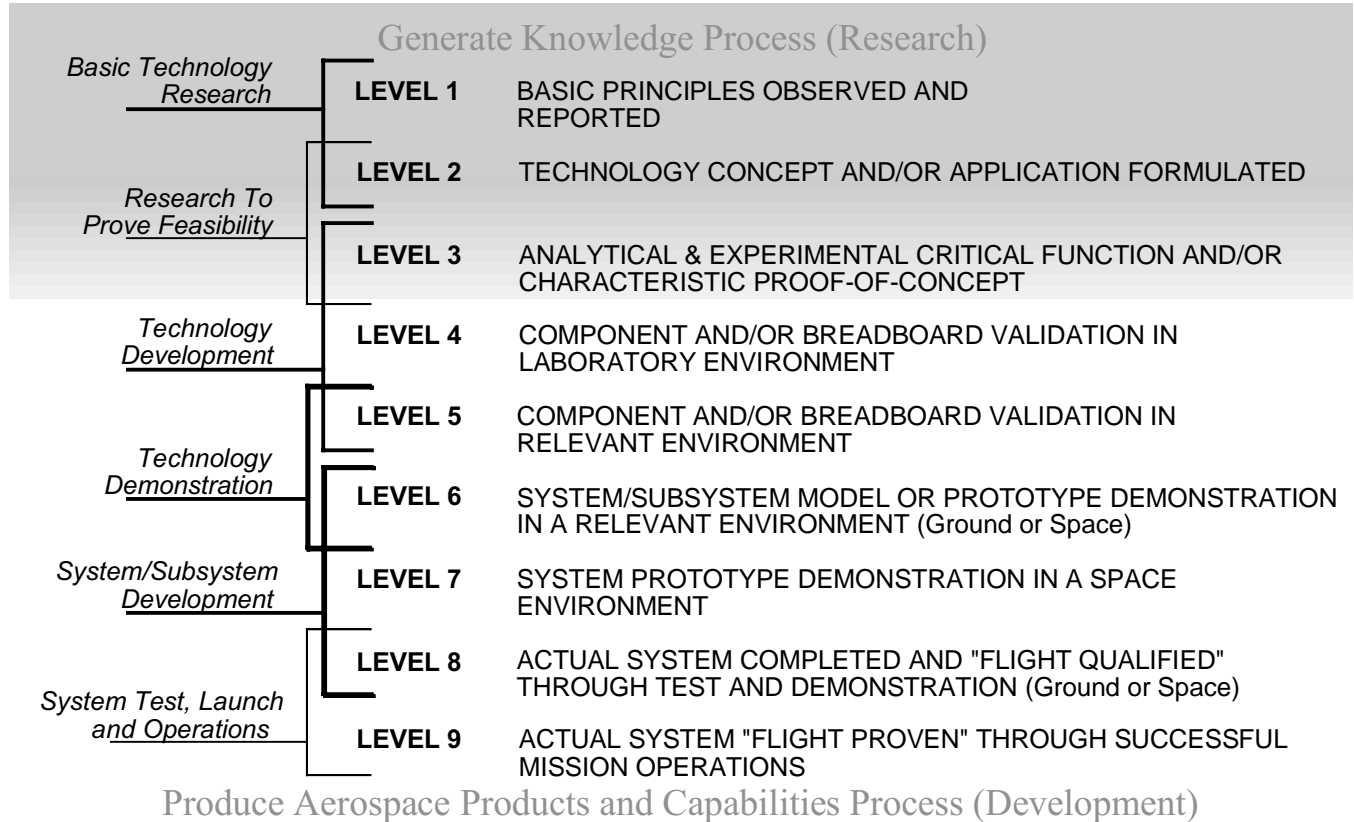


Figure L-1. Technology Readiness Level Definitions

Name of Hardware Item	Item Description	Maturity Level	Rationale for Maturity Assessment

Figure L-2 (a). instrumentation Technical Maturity Matrix

Name of Hardware Item	Item Description	Maturity Level	Rationale for Maturity Assessment

Figure L-2 (b). Spacecraft Technical Maturity Matrix

Science Objectives	Scientific Measurement Requirements	Instrument Functional Requirements	Mission Functional Requirements (Top-Level)

Figure L-3. Science Traceability Matrix

Science Measurement Requirement	Mission Requirement	Instrument Requirement	Spacecraft Requirement	Ground System Requirement	Operations Requirement

Figure L-4. Mission Traceability Matrix

Mission Assurance Element	Check all that apply	Applicable Plan, Document, Review or Program
1. Mission Assurance Program 2.1 Quality System 2.2 Standards 2.3 Non-Conformance Reporting 2.4 Operating Time 3. Reviews System Requirements Review Preliminary Design Review Critical Design Review Pre-Environmental Test Review Mission Readiness Review Launch Readiness Review Operational Acceptance Review Annual Operation Reviews 4.1 Parts Program 4.2 Materials and Processes Program 4.3 Reliability Program 4.4 Software Development Program 5. Verification Program 6. Contamination Control Program 7. Independent Mission Operations Requirements. 8. Red Team Reviews 9. Continuous Risk Management		

Figure L-5. Mission Assurance Compatibility Table

						TOTALS
Cost Element **	FY2001	FY2002	FY2003	...	FYn	RY \$K
Phase Mission Definition (if required)						
Reserves						
Total Phase Mission Definition						
Phase Preliminary Design						
Reserves						
Total Phase Preliminary Design						
Phase Mission Detailed Design, & Mission Development and Launch	Enter each cost element					
Proj. Mgmt/Misn. Analysis/Sys. Eng.						
Instrument A						
Instrument B						
Instrument						
Instr. Integr., Assy. & Test						
<i>Subtotal - Instruments</i>						
Spacecraft bus						
Spacecraft Integr., Assy. & Test						
Other Hardware Elements (1)						
<i>Subtotal - Spacecraft</i>						
Pre-Launch GDS/MOS Development						
Science Team Support						
Launch Ops (Launch + 30 Days)						
Other (2)						
<i>Subtotal Phase before Reserves</i>						
Instrument Reserves						
Spacecraft Reserves						
Other Reserves						
Total Phase Mission Detailed Design, & Mission Development and Launch						
Phase Mission Operations and Data Analysis, Archival, and Dissemination	Enter each cost element					
MO & DA						
DSN/Tracking						
Other (2)						
<i>Subtotal Phase before Reserves</i>						
Reserves						
Total Phase Mission Operations and Data Analysis, Archival, and Dissemination						
Education						
Total NASA ESE Cost						
Launch Services						
Total NASA Cost						
Contributions (2)						
Total Contributions						
Total Mission Cost =						
** Refer to definition of Program Cost Elements						
(1) Other Hardware Elements: Probes, Sample Return Canister, Etc.						
(2) Specify each item on a separate line; include Education & Public Outreach, facilities, etc.						

Figure L-6. Summary of Elements Of Cost for the Entire Project in Real Year \$K

Cost Element**	FY2001	FY2002	FY2003	FY2004	FY2005	FY2006	...	FYn	Total (Real Yr. \$K)
Phase Mission Definition and Preliminary Design	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
- Organization B									
- etc.									
Phase Mission Detailed Design, & Mission Development and Launch	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Phase Mission Operations and Data Analysis, Archival, and Dissemination	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Shuttle/ELV and services	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Other Tracking Support	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Other (specify)	\$	\$	\$	\$	\$	\$	\$	\$	\$
Total Cost to NASA	\$	\$	\$	\$	\$	\$	\$	\$	\$
Additional Contributions by Organization (Foreign or Domestic) to:									
Total Phase Mission Definition and Preliminary Design	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Total Phase Mission Detailed Design, & Mission Development and Launch	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Total Phase Mission Operations and Data Analysis, Archival, and Dissemination	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Shuttle/ELV Costs	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Tracking Support	\$	\$	\$	\$	\$	\$	\$	\$	\$
- Organization A									
Other	\$	\$	\$	\$	\$	\$	\$	\$	\$
Contributed Costs (Total)	\$	\$	\$	\$	\$	\$	\$	\$	\$
Mission Totals									\$

* Costs shall include all costs including fee

** See Program Cost Element definitions

Figure L-7. Total Mission Life Cycle Cost Phasing (FY Costs* in Real Year \$K, Totals in Real Year \$K)

PHASE _____ COST BREAKDOWN BY WBS AND MAJOR COST CATEGORY (Phased costs in Real Year Dollars, Totals in Real Year Dollars)					
WBS/Cost Category Description*	FY2001	FY2002	• • •	Total (RYS)	Leave this column blank
Total Direct Labor Cost	\$	\$	\$	\$	
WBS 1.0 Management					
WBS 2.0 Spacecraft					
WBS 2.1 Structures & Mechanisms					
WBS 2.2 Propulsion					
Etc.					
Total Direct Material and Equipment Costs	\$	\$	\$	\$	
WBS # and Description					
:					
Total Other Direct Costs	\$	\$	\$	\$	
WBS # and Description					
:					
Total Subcontracts	\$	\$	\$	\$	
WBS # and Description					
:					
Total Indirect Costs	\$	\$	\$	\$	
WBS # and Description					
:					
Total Reserves	\$	\$	\$	\$	
WBS # and Description					
:					
Fee					
Other (Specify)					
Total Contract Cost	\$	\$	\$	\$	
Total Other Costs to NASA	\$	\$	\$	\$	
Shuttle/ELV and Launch Services					
Other (Specify)					
Total Contributions (Foreign or Domestic)	\$	\$	\$	\$	
Organization A:					
WBS # and Description					
etc.					
Organization B:					
WBS # and Description					
etc.					
TOTAL COST FOR PHASE	\$	\$	\$	\$	

Figure L-8 Phase Cost Breakdown by WBS and Major Cost Category Template

Figure L-9 Costs for all Development Elements by Recurring and non-recurring Components Template
Development Costs in Real Year Dollars (to nearest thousand)

Cost Element **	TOTALS	
	Non-Recurring (RYS)	Recurring (RYS)
Instrument A (1)		
Instrument B (1)		
:		
Instrument n (1)		
<i>Subtotal - Instruments</i>		
Structure & Mechanisms		
Propulsion		
Power		
:		
Each Subsystem		
<i>Subtotal - Spacecraft Bus</i>		
Instrument Software		
Spacecraft Bus Software		
Ground Systems Software		
<i>Subtotal - Software</i>		
Other Elements (2)		
<i>Subtotal - Element</i>		
:		
:		
Total Development		

** Refer to definition of Program Cost Elements

(1) Specify each instrument by subsystems/components where possible

(2) Other Elements: Probes, Sample Return Canister, etc. Specify each separately, by subsystem wherever possible

Figure L-9 Costs for all Development Elements by Recurring and non-recurring Components Template

<u>Fiscal Year</u>	<u>Inflation Rate</u>
FY 2002	2.8%
FY 2003	2.8%
FY 2004	2.8%
FY 2005	2.8%
FY 2006 and Outyears	2.8%

Figure L-10. NASA Inflation Index

Contingency (or reserve) when added to a resource results in the maximum expected value for that resource. Percent contingency is the value of the contingency divided by the value of the resource less the contingency.

Margin is the difference between the maximum possible value of a resource (the physical limit or the agreed-to limit) and the maximum expected value for a resource. Percent margin for a resource is the available margin divided by its maximum expected value.

Example: A payload in the design phase has an estimated mass of 115 kg including a mass reserve of 15 kg. There is no other payload on the ELV and the ELV provider plans to allot to you the full capability of the vehicle, if needed. The ELV capability is 200 kg. The mass reserve is $15/100 = 15\%$ and the mass margin is 85 kg or $85/115 = 74\%$.

Example: The end-of-mission life capability of a spacecraft power system is 200 watts. Your instrument is expected to use 50 watts, including 20% contingency. You are allotted 75 watts by the satellite provider. Your reserve is 10 watts and your margin is 25 watts, or $25/50 = 50\%$.

Figure L-11. Contingency and Margin definition and examples.

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APPENDIX M

AO ACRONYMS

AA	Associate Administrator (Office of Earth Science)
ADEOS	Advanced Earth Observation Satellite
AO	Announcement of Opportunity
AMM	Antarctic Mapping Mission
ASCII	American Standard Code for Information Interchange
CCSDS	Consultative Committee for Space Data Systems
CDR	Critical Design Review
CRR	Critical Readiness Review
COM	Cost of Money
COTS	Commercial Off-The-Shelf
CRSP	Commercial Remote Sensing Program
CVCM	Collected Volatile Condensable Mass
DAAC	Distributed Active Archival Centers
DIF	Directory Interchange Format
DOS	Disk Operating System
DPA	Destructive Physical Analysis
EEE	Electrical, Electronic, and Electro-Mechanical
EEO	Equal Employment Opportunity
ELV	Expendable Launch Vehicle
EOCAP	Earth Observations Commercial Applications Program
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ERS	European Remote-sensing Satellite
ESE	Earth Science Enterprise
ESIP	Earth Science Information Partners
ESSP	Earth System Science Pathfinder
ETR	Eastern Test Range
EWR	Eastern and Western Range
EXPRESS	EXpedite the PROcessing of Experiments for the Space Station
FAR	Federal Acquisition Regulation
Fax	Facsimile
FFRDC	Federally Funded Research and Development Center
FGDC	Federal Geographic Data Committee
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects and Criticality Analysis
FY	Fiscal Year
G&A	General and Administrative
GCMD	Global Change Master Directory
GDS	Ground Data System
GIDEP	Government Industry Data Exchange Program
GLAS	Geoscience Laser Altimeter System

GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment mission
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HBCUs	Historically Black Colleges and Universities
HDF	Hierarchical Data Format
HH	Horizontal linear polarized beam transmitted and received
ICD	Interface Control Document
IIP	Instrument Incubator Program
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
ISS	International Space Station
IV&V	Independent Verification and Validation
JERS	Japanese Earth Resources Satellite
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
Landsat	Visible/near visible band Earth-imaging series of satellites
LightSAR	Lightweight Synthetic Aperture Radar
LSWG	LightSAR Science Working Group
LRR	Launch Readiness Review
LTA	Long Term Archive
L/V	Launch Vehicle
METOP	METeorological OPERational
MCR	Mission Confirmation Review
MDR	Mission Design Review
MELV	Medium-Light Expendable Launch Vehicle
MODIS	Moderate Resolution Imaging Spectrometer
MOU	Memorandum of Understanding
MRR	Mission Readiness Review
MTPE	Mission To Planet Earth (now known as Earth Science Enterprise)
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NHB	NASA Handbook
NMC	NASA Mission Cost
NMP	New Millennium Program
NOI	Notice of Intent
NPD	NASA Policy Directive
NPG	NASA Procedures and Guidelines
NRA	NASA Research Announcement
NRC	National Research Council
NSS	NASA Safety Standard
OAR	Operational Acceptance Review
OES	Office of Earth Science
OFCCP	Office of Federal Contract Compliance Programs
OMUs	Other Minority Universities

PAF	Payload Attach Fitting
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PI	Principal Investigator
PM	Project Manager
Radarsat	C-band imaging radar satellite of the Canadian Space Agency
SAR	Synthetic Aperture Radar
SDAP	Science Data Analysis Program
SE	Support Equipment
SELV	Small Expendable Launch Vehicle
SELVS	Small Expendable Launch Vehicle Services
SERF	Services Entry Record File
SF	Standard Form
SI	International System of Units
SIR-C	Shuttle Imaging Radar - C
SOMO	Space Operations Management Office
SOW	Statement of Work
SRR	System Requirements Review
SRM	Solid Rocket Motor
SSC	John C. Stennis Space Center
S/C	Spacecraft
S/W	Software
TML	Total Mass Loss
TMLCC	Total Mission Life Cycle Cost
TRL	Technology Readiness Level
URL	Universal Resource Locator
USGCRP	U.S. Global Change Research Program
VCL	Vegetation Canopy Lidar Mission
VV	Vertical linear polarized beam transmitted and received
WBS	Work Breakdown Structure
WFF	Wallops Flight Facility
WORF	Window Observational Research Facility
WTR	Western Test Range
WWW	World Wide Web
X-SAR	X-band Synthetic Aperture Radar

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APPENDIX N

GLOSSARY OF TERMS

NASA EARTH SCIENCE ENTERPRISE COST

That portion of the proposed Total Mission Life Cycle Cost to be funded by NASA for the development, integration, and operation of all hardware and software, including full costing of non-contributed Civil Service resources. This cost excludes the cost of the launch vehicle and launch services.

NASA LAUNCH SERVICES COST

That portion of the proposed Total Mission Life Cycle Cost to be funded by NASA for the acquisition of a launch vehicle and the services necessary for launch.

NASA MISSION COST

That portion of the proposed Total Mission Life Cycle Cost to be funded by NASA, including full costing of non-contributed civil service resources. This includes both the NASA Earth Science Enterprise Cost and the NASA Launch Services Cost.

CONTRIBUTIONS

That portion of the proposed Total Mission Life Cycle Cost that is provided on a no-exchange-of-NASA-funds basis.

TOTAL MISSION LIFE CYCLE COST

The total proposed mission cost, which is the sum of the NASA Mission Cost and all Contributions from the selected proposal Team partners.

COST CEILING

The maximum cost allowed under this AO. The NASA ESE Cost Ceiling for this AO is \$125M in real year dollars.

COST CAP

The cost limit, less than or equal to the cost ceiling, that the proposer commits to upon submission of the Step-Two proposal.

MISSION DEFINITION AND PRELIMINARY DESIGN PHASE

Project Formulation period that includes definition and preliminary design.*

MISSION DETAILED DESIGN AND MISSION DEVELOPMENT AND LAUNCH PHASES

Project Implementation period that includes detail design and development, mission launch, and operational validation.

MISSION OPERATIONS AND DATA ANALYSIS, ARCHIVAL, AND DISSEMINATION PHASE

Project Implementation period that includes mission operations, data collection, processing, distribution, and archiving.

SCIENCE RETURN

The combination of the proposed mission's relevance to the science priorities, goals and objectives of the Earth Science Enterprise and Earth Exploratory Mission Program; overall scientific merit; and quality, quantity, relevance and timeliness of deliverable science data products.

SCIENCE VALUE

An assessment of the relationship between science return and the proposed NASA Mission Cost.

APPENDIX O

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS PRIMARY COVERED TRANSACTIONS

This certification is required by the regulations implementing Executive Order 12549, Debarment and Suspension, 14 CFR Part 1265.

A. The applicant certifies that it and its principals:

- (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- (b) Have not within a three-year period preceding this application been convicted or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or Local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
- (c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State, or Local) with commission of any of the offenses enumerated in paragraph A.(b) of this certification;
- (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or Local) terminated for cause or default; and

B. Where the applicant is unable to certify to any of the statements in this certification, he or she shall attach an explanation to this application.

C. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lowered Tier Covered Transactions (Subgrants or Subcontracts)

- (a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principles is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any federal department of agency.
- (b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

Organization Name

AO Number and Title

Printed Name and Title of Authorized Representative

Signature

Date

Printed Proposal Team Leader Name

Proposal Title

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APPENDIX P

CERTIFICATION REGARDING LOBBYING

As required by S1352 Title 31 of the U.S. Code for persons entering into a grant or cooperative agreement over \$100,000, the applicant certifies that:

- (a) No Federal appropriated funds have been paid or will be paid by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, in connection with making of any Federal grant, the entering into of any cooperative, and the extension, continuation, renewal, amendment, or modification of any Federal grant or cooperative agreement;
- (b) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting an officer or employee of any agency, Member of Congress, or an employee of a Member of Congress in connection with this Federal grant or cooperative agreement, the undersigned shall complete Standard Form - LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (c) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subgrants, contracts under grants and cooperative agreements, and subcontracts), and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by S1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

Organization Name

AO Number and Title

Printed Name and Title of Authorized Representative

Signature

Date

Printed Proposal Team Leader Name

Proposal Title

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APPENDIX Q

CIVIL RIGHTS CERTIFICATION

Assurance of Compliance with the National Aeronautics and Space Administration Regulations Pursuant to Nondiscrimination in Federally Assisted Programs

The _____,
(Institution, corporation, firm, or other organization on whose behalf this assurance is signed, hereinafter called "Applicant")

HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-352), Title IX of the Education Amendments of 1972 (20 U.S.C. 1680 et seq.), Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. 794), and the Age Discrimination Act of 1975 (42 U.S.C. 16101 et seq), and all requirements imposed by or pursuant to the Regulation of the National Aeronautics and Space Administration (14 CFR Part 1250) (hereinafter call "NASA") issued pursuant to these laws, to the end that in accordance with these laws and regulations, no person in the United States shall, on the basis of race, color, national origin, sex, handicapped condition, or age be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives federal financial assistance from NASA; and HEREBY GIVE ASSURANCE THAT it will immediately take any measure necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of federal financial assistance extended to the Applicant by NASA, this assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this assurance shall obligate the Applicant for the period during which the federal financial assistance is extended to it by NASA.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all federal grants, loans, contracts, property, discounts, or other federal financial assistance extended after the date hereof to the Applicant by NASA, including installment payments after such date on account of applications for federal financial assistance which were approved before such date. The Applicant recognized and agrees that such federal financial assistance will be extended in reliance on the representations and agreements made in this assurance, and that the United States shall have the right to seek judicial enforcement of this assurance. This assurance is binding on the Applicant, its successors, transferees, and assignees, and the person or persons whose signatures appear below are authorized to sign on behalf of the Applicant.

Dated: _____

Applicant: _____

By: _____
(President, Chairman of Board, or Comparable Authorized Person)

(Applicant's mailing address)

OR USE NASA FORM 1206 May 2000 PREVIOUS EDITIONS ARE OBSOLETE

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APPENDIX R

**SAMPLE MISSION DEFINITION
AND REQUIREMENTS AGREEMENT**

**MISSION DEFINITION AND REQUIREMENTS
AGREEMENT**

for the

GRAVITY RECOVERY AND CLIMATE EXPERIMENT (GRACE) MISSION

**UNIVERSITY OF TEXAS
CENTER FOR SPACE RESEARCH**

July 31,1997

1.0 MISSION OVERVIEW

The primary goal of the GRACE mission is to obtain accurate global and high-resolution models for both the static and the time variable components of the Earth's gravity field. This goal will be achieved by making accurate measurements of the inter-satellite range and range rate between two co-planar, low altitude polar orbiting satellites, using a micro-wave tracking system. In addition, each satellite will carry geodetic quality Global Positioning System (GPS) receivers and high accuracy accelerometers to enable accurate orbit determination, spatial registration of gravity data and the estimation of gravity field models.

The gravity field estimates obtained from data gathered by the GRACE mission will provide, with unprecedented accuracy, integral constraints on the global mass distribution and its temporal variations. In the oceanographic community, the knowledge of the static geoid, in conjunction with satellite altimeter data, will allow significant advances in the studies of oceanic heat flux, long term sea level change, upper oceanic heat content, and the absolute surface geostrophic ocean currents. Further, the estimates of time variations in the geoid obtained from GRACE, in conjunction with other in-situ data and geophysical models, will help the science community unravel complex processes in oceanography (e.g. deep ocean current changes and sea level rise), hydrology (e.g. large scale evapo-transpiration and soil moisture changes), glaciology (e.g. polar and Greenland ice sheet changes), and the solid Earth Sciences.

This mission will be relevant to the goals of both MTPE EOS and the USGCRP. Implementation of the mission will be efficient and cost effective due to international collaboration. The GRACE Principal Investigator (PI), Dr. Byron Tapley of the University of Texas, Austin Center for Space Research (UTCSR), has established teaming arrangements with a Co-Principal Investigator, Prof. Dr. Christoph Reigber of the GeoForschungZentrum (GFZ), Germany; the Jet Propulsion Laboratory (JPL), Space Systems Loral (SS/L), the Dornier Satelliten Systeme, GmbH, the Applied Physics Laboratory (APL) at Johns Hopkins University, ONERA and the Langley Research Center (LaRC) to implement the GRACE mission. The PI will have overall responsibility for the total mission, including the instrument, spacecraft, ground system, mission planning and operations, data processing and analysis, and data distribution. Dr. Tapley will be supported by experienced management and engineering teams, which have established close and efficient working relationships. The Deutsche Forschungsanstalt für Luft und Raumfahrt (DLR) and GFZ will work under an International Memorandum of Understanding (IMOU) between NASA and DARA (Germany). JPL and LaRC will perform under task orders from the Goddard Space Flight Center (GSFC) ESSP Project Office. SS/L, Dornier, APL and ONERA will perform under contract with JPL.

2.0 SCIENCE OBJECTIVES

2.1 Baseline Science Mission

Primary Objective:

The primary objective of the GRACE mission is to provide gravity models with accuracies that better existing global and high spatial resolution models of the Earth's gravity field by at least an order of magnitude, on a monthly basis, for a period of up to 5 years. The temporal sequence of gravity field estimates provides the mean (or static) gravity field, as well as a time history of its temporal variability. The scientific data products to be generated by GRACE including the line of sight inter-satellite tracking, GPS and accelerometer measurements, along with the ancillary data will be made available to the science community via the PODAAC at JPL in an EOS compatible format, shortly after validation for the entire life of the mission.

Secondary Objectives:

The secondary objectives are related to demonstrating the ability of the gravity measurements to discriminate time varying changes in the mass of the Earth's dynamic system, and to provide additional data to support investigation of the Earth's atmosphere. Specifically, these secondary objectives are:

- To demonstrate the ability to monitor the time varying effects due to sea level rise, water storage, ice change, and other geophysical phenomena, from a temporal sequence of gravity measurements.
- To advance atmospheric model studies by collecting several hundred globally distributed profiles of the ionosphere and the atmosphere every 24 hours, using GPS limb-sounding.

Baseline Science Objectives Summary

Accurate and high resolution estimates of the mean and time variable parts of the Earth gravity field will be obtained from satellite-to-satellite tracking data gathered from the GRACE mission. The mean value and time variations of the spherical harmonic coefficients of the Earth gravity field will be estimated using 12 to 24 day batches or cycles of these data. The accuracy of the estimated spherical harmonic coefficients can be expressed as the global root mean square (rms) error in the resulting area mean geoid height over a disk of a specified radius (or spatial resolution). Using 90 days of data, the nominal GRACE mission scenario will yield geoid height accuracies of better than 0.01 mm for spatial resolutions larger than 3000 km, increasing to 0.02 mm at 1000 km, 0.05 mm at 500 km and 5 mm at 100 km spatial resolutions.

These nominal GRACE gravity field estimation errors can be further specified in terms of the primary science applications, as detailed in the original proposal. Table 1 presents the spatial and, where appropriate, temporal scales for the associated geoid accuracy requirements to support each scientific applications

Table 1 Baseline science objectives summary

APPLICATION	SPATIAL RESOLUTION	TIME SCALE	ACCURACY	COMMENTS
STATIC GRAVITY FIELD				
Oceanic Heat Flux	> 1000 km		> 40 percent improvements	
Ocean Currents	> 1000 km		< 1 mm geoid error	Improves to <0.1 mm for longest scales
Solid Earth Sciences	200 km		approx. 1 cm geoid error	
TIME VARIABLE GRAVITY FIELD				
Ocean Bottom Pressure	> 500 km	Seasonal	0.05 mBar pressure	90 day estimate
Deep Ocean Currents	> 500 km	Seasonal	1 cm/sec current velocity	90 day estimate
Sea Level Rise	> 700 km	Secular	0.1 mm/yr. water level	5 year estimate
Evapo - Transpiration	> 300 km	Seasonal	< 1 cm water equivalent	30 day estimate
Aquifer Depletion	> 300 km	Secular	1 - 2 mm/year water equivalent	5 year estimate
Greenland / Antarctic Ice		Secular	0.4 - 0.8 mm/yr. ice thickness	5 year estimate
- do -		Seasonal	3 - 10 mm ice thickness	1 year estimate

2.2 Minimum Science Mission

As a minimum goal for a successful mission, the GRACE measurements shall support the requirement for at least an order of magnitude improvement in the marine geoid. This improvement will enhance dramatically the recovery of the general ocean circulation and ocean heat flux from satellite altimetry. This improvement is a current requirement of both the MTPE EOS and the World Ocean Circulation Experiment. To achieve minimum objectives of the GRACE mission, a static gravity field with a cumulative error of 5 mm root mean square over wavelengths 800 km and longer shall be obtained. This will require separating the static and time varying signals during the observation interval. This goal shall be readily attainable on the basis of one year of calibrated and validated data from GRACE's dual satellite microwave tracking system.

2.3 Science Data Products

2.3.1 Science Data Rights

There will be no proprietary science data rights for the mission. Science data will be made available to the public and the science community in an EOS compatible format after the appropriate science calibration and validation. The data and the associated higher level products will be made available in batches or cycles of 14 to 30 days each.

The Level-1 data products include the calibrated and verified satellite-to-satellite line of sight biased range and range rate, along with the GPS tracking data and precise ephemerides for the GRACE satellites. These data will be made available to the scientific community within 30 days of the last observation in each cycle.

The Level-2 data products include validated solutions for cycle averages of the Earth gravity field, in the form of coefficients of a spherical harmonic expansion and their time variations. These data products will be provided along with the equivalent 1x1 degree area mean geoid height and gravity anomalies on a global and regional basis. In addition, the one year average Earth gravity field model in the form of spherical harmonic coefficients as well as geoid height and gravity anomaly maps will be provided. The Level-2 products will be made available within 90 days of the last observation in each cycle.

The Level-3 data products contain higher level solutions targeted for geophysical quantities of interest. These include apparent changes in the 500 km disk averaged ocean bottom pressure as well as continental water storage over each cycle or averaging interval, as well as their longer term (annual and secular) variations. The Level-3 data products will be funded through a separate GRACE Mission Science Data Analysis Program and will be available on a schedule that is consistent with the selected investigation objectives.

2.3.2 Measurement Requirements

The Level 1 science measurement requirements are contained in Table 2. These requirements are consistent with successful accomplishment of the science objectives listed in paragraph 2.1 above.

Table 2 Level 1 Science Requirements

Science Investigation	Instrumentation	S/C	Ground Ops	Mission Design	Mission Ops.	Comments
Earth Gravity Field	m-wave SST link, GPS Rcvr, Accelerometer	2	Data Rate: 20 Mb/day	Inc 83°-90° Alt 450 km Life 5 yrs Sep 200 km	Orbit Maneuver Every 12 to 60 days	< 1m/s SST < 1 nm/s ² Accelerometer
Atm Occult	GPS Rcvr.	1	Data Rate: 20-40 Mb/d			

2.3.3 Descope Options

A cascade of options for descoping the implementation and operations efforts (i.e., a Descope Plan) will be developed during the Mission Definition and Preliminary Design phase. The Descope Plan will provide clarity in terms of how the primary scientific applications will be affected as each descope option is implemented. As a minimum, the Descope Plan will address any reductions in technical accuracy, mission lifetime and science data products. The descope options leading to the minimum science requirements described in Section 2.2 will be defined during the Mission Definition and Preliminary Design phase effort.

3.0 MISSION AND PROJECT REQUIREMENTS

3.1 Mission Cost and Budgetary Requirements

The GRACE mission will be undertaken on a "design-to-cost" basis. As proposed, the mission shall be accomplished with a cost to NASA of no more than \$X. Failure to keep the estimated cost to complete the mission at any stage of the development of the mission may be cause for termination. Annual funding will be reflected in contracting vehicles between NASA GSFC and the implementing organizations. Adjustments within the overall "design-to-cost" funding level will be made between years through the normal contracting process. Approval will be sought from NASA for reductions in funding for "opportunity" activities.

3.2 Schedule

The Level-1 schedule milestones are listed below:

Project Requirements Review	Apr 1998
Mission Design & Cost Review	Dec 1998 (or sooner)
Critical Design Review	Mar 1999

Pre-Ship Review	Mar 2001
Internal Progress Reviews	(bi-annual)
Deliver Spacecraft to Launch Site	Jun 2001
Launch	Jul 2001
End of Mission	Jul 2006

3.3 Management System

The mission will establish an effective and efficient management system which will assure that the science objectives can be accomplished within the schedule and cost limitations. As a minimum the following management requirements will be met:

- The GRACE mission will be undertaken on a "design-to-cost" basis;
- All hardware and software will be verified through robust testing;
- Quality assurance program will be consistent, or exceed, standards set in ISO 9000;
- The Principal Investigator (PI) will exercise overall responsibility for the mission implementation and the leadership of the US Science Team;
- The PI will form and chair a Project Management Team (PMT) which will coordinate all program elements between organizations in both countries;
- The Co-PI will serve as a member of the PMT, lead the European Science Team, and provide management oversight of all German operations in support of this project;
- The Project Manager (PM), acting through JPL, will lead the satellite and system implementation effort, and be responsible for the mission and systems engineering team;
- DLR will be the lead agency for the mission operations effort of this project;
- GFZ will be the lead agency for the launch vehicle of this project

Any requisite modifications to these requirements for Phase C, D and E will be defined during Phase B.

3.3.1 Scheduling

A fully integrated scheduling system will be established and implemented during Phase B to manage all project elements. This system will include the development of network schedules and critical paths. A Level-1 baseline schedule will be developed during Phase B and approved by NASA.

3.3.2 Performance Metrics

A system to measure mission progress will be established and implemented during Phase B which is compatible with the scheduling and cost control systems.

3.3.3 Key Personnel

Changes in the key personnel, defined as the Principal Investigator and the Project Manager, will be subject to NASA approval. The key DARA and DLR personnel will be approved by the respective organizations.

3.3.4 Contract Deliverables

Major contracts which are developed as part of the mission will reflect the science nature of the investigation. As appropriate, deliverables will focus on the science products, and incentive plans will reflect the science deliveries. For this mission, primary emphasis is placed on cost and schedule.

3.3.5 Incentive Fee Plans

Implementation contracts will provide incentives to the contractor for both adherence to cost commitments and technical performance. Subcontracts from JPL for the GRACE Mission are currently in negotiations. Subcontractors include the Johns Hopkins Applied Physics Laboratory, Dornier Satelliten Systeme, Space Systems Loral and ONERA. Upon completion of contract negotiations, a discussion of fee pools and incentive plans will be added to this section.

3.4 Legal Requirements

The Project will abide by all necessary U.S. federal (including NASA), state and local laws and regulations.

3.5 New Facilities

There are no new project specific major facilities required for this mission

3.6 Descope Plan

The PI is responsible, directly and indirectly, through recommendations to the GSFC Mission Manager, for implementing the Descope Plan when it appears that the mission cannot meet its baseline science requirements. If a descope is necessary, the Descope Plan will describe how the Mission will meet the minimum science, budget and schedule requirements.

4.0 MISSION RESPONSIBILITIES

4.1 Principal Investigator and Science Team

The Principal Investigator (PI) will be responsible to NASA for achieving the objectives of the mission. The PI will establish and chair the Project Management Team (PMT) in order to coordinate the elements of the mission being executed by all the participants. The PI shall approve the designation of a single individual as Project Manager at JPL, and shall delegate to this individual the requisite responsibility and authority to manage and administer the effort to implement the GRACE mission. Decisions dealing with mission objectives will be made by the PI, in consultation with the PMT. The PI will also lead the scientific analysis team responsible for data analysis and distribution.

The Co-Principal Investigator (Co-PI), Prof. Dr. Christoph Reigber of GFZ, will be responsible to the PI for oversight of launch and on-orbit operations in fulfilling the mission requirements. He will also provide leadership of the European Science Team.

The Project Manager (PM) shall have delegated to him the requisite responsibility and authority to manage and administer the effort to implement the GRACE mission. This individual shall be the focal point of contact for GSFC. The PM shall ensure that all the objectives associated with the implementation effort are accomplished within schedule and cost constraints, and provide timely reporting of overall progress.

The tasks of the PMT, which consists of the PI, Co-PI, PM and other designated individuals, are to ensure that the program is guided in a responsive manner to maximize the science gains for the mission cost consistent with the constraints of ESSP.

The Science Team will be as described in the Science Requirements sub-section (Section 2.9) of the original proposal. The PI may change the composition of the science team to meet the objectives of the Mission, with notification of such changes to the ESSP Project Office. International participation will be consistent with the NASA/DARA Memorandum of Understanding.

4.2 Industrial Partners

Space System/Loral (SS/L) will perform the satellite system engineering, assembly, integration, and verification testing (AIVT).

The Dornier Satelliten Systeme, GmbH, an affiliate of Daimler-Benz Aerospace (DASA) will initiate the satellite system engineering process in a manner that optimizes the inheritance from Germany's CHAMP Mission, and is responsible for development of the thermal, structural and power systems of the satellites, and will also support launch integration on the COSMOS and launch operations.

4.3 Other Pre-selected Subcontractors

The Applied Physics Lab (APL) at Johns Hopkins University will develop the ultra stable oscillators (USO) to be used for the frequency standards in the SST tracking systems.

ONERA (France) will provide the accelerometers for the two satellites.

5.0 NASA RESPONSIBILITIES

The NASA HQ Code IY will provide support in the development of a Memorandum of Understanding (MOU) with the international partners on the GRACE mission. The GSFC ESSP Project Office will provide mission funding, contract administration and programmatic oversight for the GRACE mission. To implement the GRACE Mission, the ESSP Project Office will provide funds directly to three members of the GRACE Team - UTCSR, JPL and LaRC, as requested by the PI. Furthermore, the ESSP Project Office may provide other mission unique

support, only as may be requested by the PI in writing and agreed upon by the ESSP Project Manager. In the event such support is requested, a portion of the PI's Mission Funds would be retained by the ESSP Project Resources Office, to be disbursed as requested by the PI.

6.0 REPORTING AND NASA REVIEWS

Reporting requirements and NASA reviews will be kept to a minimum while ensuring that NASA maintains an effective understanding of the progress of the development and execution of the mission. To this end, reports and supporting materials will be based on internal Project products and processes to the maximum extent practical. The details will be developed during Phase B between the PI, the Project Manager and the NASA Mission Manager.

NASA reviews will be conducted annually typically in conjunction with major project reviews by a team appointed by the ESSP Project Office to assess the progress of the mission and its readiness to proceed to the next phase. These reviews will assess technical, cost and schedule progress to verify that the project can be completed in accordance with the Level-1 requirements within the cost and schedule commitments. The results of these reviews will be reported to the Earth Science Systems Program Office, (ESSPO), to confirm that the mission shall be continued.

APPENDIX S

ESSP Documents Required by MDR

Note: This Appendix to the ESSP AO is a list of the documents required by the Mission Design Review for Earth Explorers at the NASA Goddard Space Flight Center, and is representative of the documentation required at other NASA Centers. In accordance with NASA's plan to transfer program management responsibility to the Field Centers and designate Lead Centers for multi-center programs, Goddard Space Flight Center is assigned the Lead Center responsibility for Earth Explorers Projects, including the Earth Systems Science Pathfinder (ESSP). As Lead Center, Goddard will be responsible for establishing and tracking program metrics and for reporting program status and progress to NASA Headquarters.

1. Project Plan
2. Descope Plan
3. Risk Management Plan
4. Science and Mission Requirements Document
5. MOU (if necessary)
6. S/C System Specification
7. Instrument Specification
8. S/W Development Plan
9. S/C to Ground ICD (draft)
10. L/V to S/C ICD (draft)
11. S/C to Instrument ICD
12. Science Data System Development Plan (draft)
13. Outreach Plan
14. Education Plan
15. Mission Operations Systems Development Plan (draft)
16. FMECA (preliminary)
17. Fault Tree Analysis (preliminary)
18. Probabilistic Risk Assessment (preliminary)
19. IV&V Plan (draft)
20. Monthly Management Reports
21. Network Schedule and Schedule Slack Report